Eight New *Planipapillus* (Onychophora: Peripatopsidae) from Southeastern Australia

AMANDA REID

140 Napoleon Street, Eltham, Victoria 3095
E. mail: mandyr@connexus.net.au

Reid, A. (2000). Eight new *Planipapillus* (Onychophora: Peripatopsidae) from southeastern Australia. *Proceedings of the Linnean Society of New South Wales* **122**, 1-32.

Eight new *Planipapillus* Reid, 1996 (Onychophora) are described from southeastern Australia: *P. annae,* sp. nov.; *P. berti*, sp. nov.; *P. biacinoides*, sp. nov.; *P. cyclus*, sp. nov.; *P. gracilis*, sp. nov.; *P. impacris*, sp. nov.; *P. tectus*, sp. nov. and *P. vittatus*, sp. nov. The generic diagnosis is emended to add some characters that were not included in the original diagnosis. *Planipapillus* are widespread throughout the southern highlands of Australia and the adjacent escarpment and it is likely that many more, particularly cryptic species, await discovery.

Manuscript received 14 September 1999, accepted for publication 19 April 2000.

KEY WORDS: Peripatopsidae, *Planipapillus,* southeastern Australia, taxonomy.

INTRODUCTION

Australia has more described species of Onychophora (Peripatopsidae) than any other continent. It remains to be seen whether this is a reflection of a focused research effort in this country in recent years, or a true representation of the biogeography of the group. It appears that New Zealand may also have a rich onychophoran fauna (Tait and Briscoe 1995; Gleeson 1996; Trewick 1998). The Australian fauna was recently reviewed by Reid (1996). Fifty six nominal species were recognised in that paper, though many were identified as belonging to probable cryptic species complexes. This was recently confirmed for one putative species, *Euperipatoides rowelli* Reid, 1996 using microsatellite markers (Sunnucks and Wilson 1999) and has been suggested for other species on the basis of numerous allozyme studies (Briscoe and Tait 1993). Thus, the true number is probably far greater than the tally of nominal species due to high levels of local endemism in the family, morphological crypsis, and the vast extent of hitherto unexplored potential onychophoran habitat in this continent.

New members of a single genus, *Planipapillus* Reid, 1996 are described here. This genus is restricted to southeastern Australia and its members are found from the southern highlands, at altitudes of up to 1,737 m within the treeline leading up to Mt Kosciuszko (2,228 m), to the eucalypt forests of the adjacent escarpment in the southeast corner of the country. Like other onychophorans, they are found in humid micro-habitats; occurring primarily in and under decomposing logs and leaf litter in a range of forest types, including remnant rainforest pockets (such as the Tarra-Bulga National Park in South Gippsland) as well as open dry sclerophyll forests. Onychophorans are commonly thought to occur in lush, moist forest habitats but in many cases the macro-habitats where *Planipapillus* spp. are found are relatively dry and may be far from pristine (Fig. 6).

Planipapillus was so-named to highlight a very characteristic trait of its members: a patch of reduced papillae on the heads of males. Modifications of the heads of male Peripatopsidae are postulated to be secondary sexual characters with a possible role in the transfer of spermatophores to females. Spermatophores have been found associated with these structures in some species (Tait and Briscoe 1990) and mating has been observed on two occasions: in an undescribed species (Meredith 1995, Tait pers., comm.) and in *Planipapillus annae,* sp. nov. described here.

The author's (1996) revision was based primarily on museum specimens and extensive collecting throughout New South Wales. Specimens from southern Australia were poorly represented in these collections. The present study is part of a wider project to redress this problem through the collection and identification of onychophorans from southeastern mainland Australia. Only *Planipapillus* species are included in this paper, though members of this genus were often collected with undescribed *Ooperipatus* Dendy, 1900. Members of the latter genus, will be described elsewhere.

Four species of *Planipapillus* were described previously: *P. biacinaces,* Reid, 1996; *P. bulgensis;* Reid, 1996; *P. mundus* Reid, 1996 and *P. taylori* Reid, 1996. Eight new species are described below.

MATERIALS AND METHODS

Specimen Collection and Preservation

This study is based on the examination of preserved specimens, most of which were hand collected from within and under decomposing logs. Specimens were preserved partially following the method of Reid (1996). Animals were anaesthetised by exposure to ethyl acetate vapour for 10 min, dipped in 70% ethanol to render the cuticle less hydrophobic, and fixed in 4% formalin for 2–3 days, then stored in 70% ethanol. Animals preserved in this way are distended, enabling characters to be examined more easily than is possible in contracted specimens.

Tissue Preparation for Transmitted Light Microscopy

Cuticular tissue was cleared in a small volume (approximately 1 ml) of saturated potassium hydroxide (KOH/H_2O) solution on a hotplate set at approximately 50°C. Following clearing (approximately 1 hr; tissue appears translucent), a drop of 1% aqueous aniline blue was added with sufficient lactic acid (approximately 2 drops) to neutralise the solution, rendering the aniline blue the correct colour for staining. [In extreme alkaline conditions (KOH/H_2O solution) aniline blue appears red; neutralising the solution, or making it slightly acidic, restores the blue colour of the stain.] Tissue pieces were stained for 15 mins, rinsed in water and mounted in glycerol jelly. The stained and mounted tissue was examined using a compound microscope and drawings made using a camera lucida.

This method differs slightly from that of Reid (1996). Washing tissue pieces after clearing, as detailed in Reid (1996), has proved very difficult (cleared tissue pieces are difficult to see, and consequently often lost during washing) and time consuming, so this step has been eliminated from the method.

For males and females of each species, the following tissue samples were prepared as above: dorsal integument, nephridiopores, crural papillae (where present) from oncopods 3, 7 and 12, and anterior accessory gland papillae and posterior accessory gland foramen. Unfortunately, no diagnostic differences were found in these characters among the eight species described (and the four *Planipapillus* described in Reid, 1996), so few are illustrated.

Terminology

Terminology for all characters follows Reid (1996). Head width is used as an indicator of size as this measure is less prone to variation due to the degree of distension of the body than are other size indicators, such as total length. Where measurements and counts are given, these refer only to type specimens. Measurement values are expressed as minimum-mean-maximum.

Abbreviations

EDI	eye diameter index, expressed as a proportion of head width
HWE	width of head measured dorsally between the midpoint of each eye
MV	Museum Victoria

Taxonomy

Morphological variation within and among populations was assessed to identify species.

A phylogenetic analysis based on morphological characters was attempted, but no clades within *Planipapillus* were clearly resolved. As many characters that differ among species relate to the male modified head papillae, it is difficult to be satisfied that assumptions of character independence can be met when conducting such an analysis.

The generic description given below comprises characters present in all *Planipapillus* species. Only characters that differ among species are given in the species descriptions.

Species descriptions were generated using DELTA (Description Language for Taxonomy) software (Dallwitz 1980; Partridge et al. 1993; Dallwitz et al. 1993).

TAXONOMY

Genus ***Planipapillus*** Reid

Planipapillus Reid, 1996: 851–852, fig. 30.

Type species: *Planipapillus taylori* Reid, 1996: 853–856, Figs 71, 119, 120. Type: holotype ♂, (AM KS40020).

Diagnosis (emended from Reid, 1996)

Colour pattern comprises: longitudinal light-coloured band along dorsal midline and short, dark, transverse bars or blotches along midline dorsal to oncopods; light dorsolateral transverse patches in line with oncopods and light patches laterally between oncopods (components are variably present within and among species). Males with an ovoid patch of reduced papillae posterior to eyes. Vas deferens continues directly (without looping posteriorly) from vasa efferentia to gonopore. Females with, or without crural papillae. Oviparous.

Generic description

Colour pattern

Body pigmented. Pigment not soluble in alcohol. Primary papillae light basally, dark tipped; longitudinal light-coloured band along dorsal midline and short, dark, transverse bars or blotches along midline dorsal to oncopods; light dorsolateral transverse patches in line with oncopods and light patches laterally between oncopods (components are variably present within and among species). Ventral organs whitish. Oncopods colour similar to, or slightly paler than body.

Antennal rings

Approximately 30 antennal rings in adults and juveniles; wide and narrower antennal rings alternate; each with single row of bristles; proximal antennal rings expanded ventrally to form sensory pads.

Eyes

Present.

Head (males)

Modified papillae (i.e. different from remaining dorsal papillae) present; an ovoid patch of reduced papillae posterior to eyes; papillae adjacent to patch usually enlarged. No eversible head structure, furrow between antennae, or modified papillae anterior to eyes.

Jaws

Inner jaw with 4–6 (usually 5) denticles; diastema absent. Outer jaw with accessory tooth.

Integument

Dorsum with 12 complete plicae between oncopods; wide and narrow plical folds alternate. Papillae not uniform in size, alternate plicae with some slightly larger, usually primary papillae. Papillae arrangement: primary papilla with short, narrow bristle between pair of larger primary papillae with longer, more robust bristles and smaller secondary papillae between primary papillae; conical apical piece absent; papillar scales ribbed in both sexes, remaining integument with small scales. Lateral primary papillae slightly enlarged or elongate, with more prominent pair between oncopods in line with junction of oncopods and body. Size of papillae posterior to gonopore similar to rest of ventrum, approximately same size dorsally and ventrally, with only those surrounding anal opening enlarged.

Oncopods

Number of pairs of oncopods invariant intraspecifically; 15 pairs in both sexes. Last pair of oncopods fully developed in both sexes; orientation as for remaining oncopods. First pair of oncopod feet not enlarged, similar in size to remaining feet. Basal foot papillae absent. Distal foot papillae present, one anterior, one median, one posterior; each papilla with single sensory bristle. Oncopods with three complete spinous pads; fourth broken spinous pad present; spinous pads well-developed on all oncopods. Nephridiopores at center of third spinous pad on fourth and fifth oncopod pair; nephridiopore openings crescent-shaped, surrounded by smooth lip.

Male reproductive tract

Gonopore (both sexes) between last pair of oncopods. Male genital pad low, rounded, not protuberant or penis-like; composed of large papillae with ribbed scales; papillae sometimes fused surrounding gonopore; gonopore shape cruciform (with arms equidistant), arms extending close to rim of genital pad. Vasa efferentia with thin flexible walls; proximal vasa efferentia broad; vas deferens not thick walled, opaque, not shiny. Spermatophore pouch present.

Male glands and gland papillae

Crural glands and crural papillae present. Crural papillae protrude between plicae 4–5 (counting from third spinous pad); with finely ribbed scales basally, distally scales broad, with distinct ribs; open via short slit; smooth rim surrounding distal foramen ovoid or lip-shaped, not extending to papilla margin. Some crural glands extend from oncopods into lateral haemocoel, while others are confined within oncopods. Coxal organs absent. Anterior accessory gland papillae present, or absent; if present, open on genital segment at base of last pair of oncopods via longitudinal slit. Anterior accessory glands present, or absent. Posterior accessory glands present; open directly to exterior on anal segment approximately midway between genital and anal openings; gland foramen separate, close together; glands broad and saccate.

Female reproductive tract

Females with ovipositor; oviparous; gonopore shape longitudinal slit. Ovarian tubes separate, suspended along entire length to pericardial floor; with thin walls; oviducts unite close to ovary. Ova follicular; large, yolky. Spermathecae present, well-developed. Receptaculum ovorum absent. Additional pouches present.

Remarks

The generic diagnosis has been emended to include characters relating to the colour pattern, and the presence of crural papillae in females. Features of the colour pattern are very distinctive in members of this genus. These were not included in the original diagnosis. However, with the description of more *Planipapillus* species, it has become apparent that components of the pattern are present in all members of the genus known thus far and are useful traits to recognise, and help define the genus.

The possession of crural papillae in females, although not present in all species, is a trait that occurs in only two other onychophoran genera, *Peripatopsis* Pocock, 1894 and *Tasmanipatus* Ruhberg et al., 1991, and is, therefore, useful to include in the generic diagnosis for *Planipapillus.*

The posterior section of the male reproductive tract, showing the vas deferens and part of the vasa efferentia, is illustrated for each species (Fig. 4). [Complete tracts are shown for *P. berti,* sp. nov. (Fig. 9a), and *P. impacris*, sp. nov. (Fig. 16).] While some slight differences are apparent, the overall structure is very similar in each species. When the tracts are swollen with sperm, the vasa efferentia are usually separate, but in other specimens the vasa efferentia lie parallel for part of their length (compare Figs 4h and 4i, and Figs 9a and 16). In all species, the vas deferens continues directly from the joined vasa efferentia to the gonopore. This trait is characteristic for members of this genus. In most other Peripatopsidae, the vas deferens continues anteriorly for a short distance before looping, hairpin-like, posteriorly toward the gonopore following the junction of the vasa efferentia.

Planipapillus annae, sp. nov.

(Figures 1a; 1b; 2a; 3; 4a; 5a; 5b; 7. Table 1)

Material examined

Holotype: ♂, Victoria, 5.9 km NW Bonang, beside Deddick R. Rd (between Bonang and Tubbut), 37°11'S 148°41'E, 740 m, 14 Jun 1999, coll. A. Reid and A. Skates (MV K7281). Paratypes: Victoria, 5♂ 5♀, data as for holotype (MV K7282).

Diagnosis

Body with mid-dorsal dark stripe; without median longitudinal light-coloured band; antennal rings not banded. Ovoid patch of reduced papillae on heads of males without sclerotised spikes; 21–24 rows of plicae comprise patch; 2–3 rows papillae lateral to patch elongate, all similar length, each with single sensory bristle. Anterior accessory glands and gland papillae absent. Posterior accessory glands straight or folded distally, short hook.

Description

Measurements

HWE males 0.87–0.91–1.00 mm (n=5, Holotype 0.90 mm HWE); HWE females 0.87–0.97–1.00 mm (n=5).

Colour pattern

Ground colour greyish-blue, or olive green. Mid-dorsal dark stripe present; short, dark, transverse bars or blotches along midline dorsal to oncopods (indistinct in dark specimens); evenly scattered tan or tan-based papillae (Fig. 1a); laterally with longitudinal light band dorsal to oncopods, or with light patches between oncopods (indistinct). Oncopods with cream patches at junction with feet. Papillae around anal opening pigmented as for rest of body. Ventral pigment present, very pale. Spinous pads greyish-blue. Integument between genital and anal openings darker than rest of ventrum.

Antennal rings not banded, ground colour.

Antennal rings

Distal 8–9 antennal rings with sensory bulbs; sensory pads with two rows of sensilla.

Eyes

EDI males 0.06–0.06–0.07; EDI females 0.06–0.06–0.07.

Head (males)

Males with modified papillae on head (i.e. differ from remaining dorsal papillae). Papillae reduced in longitudinal ovoid patch posterior to eyes (Figs 1b, 2a and 3). Patch without sclerotised spikes at medio-posterior margin. Ovoid patch comprising 21–24

Table 1. *Planipapillus* spp. distinguishing features. Symbols and abbreviations : A = Absent; B = banded; BL = mid-dorsal blotches dorsal to oncopods; BO = light band laterally above oncopods; C = cylindrical papillae; DS = mid-dorsal dark stripe; HP = male patch of modified head papillae; LB = longitudinal tan or light brown band along dorsal midline; NB = not banded; P = Present; PO = light patches laterally between oncopods; S = semicircular papillae; TP = pale dorso-lateral transverse patches; * not all specimens examined show all traits; # numbers refer to oncopod numbers.

	Colour pattern*	Antennal rings	HP spikes	HP rows of plicae	HP enlarged papillae rows / shape	HP sensory bristles (enlarged papillae)	Papillae within patch	Male crural papillae/ *crural glands extending into lateral haemocoel #*	Anterior accessory gland papillae	Anterior accessory glands	Posterior accessory glands	Female crural papillae #
P. annae, sp. nov.	BL, BO, DS, PO	NB	A	21–24	2–3 laterally; 1 posteriorly / C	1	short, smooth ridge	2–3 and 6–14/ *11–14*	A	A	folded, short hook or straight, blunt	A
P. berti, sp. nov.	BL, LB, PO	B	A	18–22	1–2 laterally, inner row longest / C	up to 3	short, smooth ridge	2–3 and 6–14/ *11–14*	A (usually)	A	straight, blunt	A
P. biacinaces Reid, 1996	BL, LB, PO, TP	B	2 short	10–11	2–3 laterally / C	1	low, smooth, conical	2–3 and 6–14/ *11–14*	P	greatly reduced	folded, short hook	2–3(?) and 6–14
P. biacinoides, sp. nov.	BL, LB, PO, TP	B, NB	2 short	6–7	2–3 laterally / C	1	low, smooth, conical	2–3 and 6–14/ *11–14*	P	greatly reduced	folded, short hook	P
P. bulgensis, Reid, 1996	BL, LB, PO	B	A	16	2–3 laterally / C	1	short, smooth ridge	2–3 and 6–14 *11–14*	A	A	straight, blunt	A
P. cyclus, sp. nov.	BL, BO, DS, LB	B, NB	4 subequal	6–7	1, entire margin / S	up to 4	greatly reduced, smooth	2–3 and 6–14/ *6–14*	P	short	folded, long hook	2–3 and 6–14
P. gracilis, sp. nov.	BL, PO	B, NB	A	19–20	1–2 laterally, inner row longest; 1 posteriorly / C	up to 3	short, smooth ridge	2–3 and 6–14/ *11–14*	A (usually), or greatly reduced	A	straight, blunt, or pointed	A
P. impacris, sp. nov.	BL, DS; LB, PO, TP (LB and TP juvenile only)	B, NB	4 subequal	6–7	1 entire margin + 1 dorsolateral and 1 ventrolateral pair in 2nd row / S	up to 7	greatly reduced, smooth	6–14/ *9–14*	P	greatly reduced	folded, long hook	6–14
P. mundus Reid 1996	DS, LB, PO	B	A	19–24	2–3 laterally / C	1	short, smooth ridge	1 or 2–3 and 6–14/ *11–14*	A	A	straight, blunt	A
P. taylori Reid, 1996	BL, DS, LB, PO, TP	B	4 equal	10–11	2–3 rows entire margin / C	up to 15	short, smooth ridge	6–14/ *6–14*	P	greatly reduced	folded, long hook	6–14
P. tectus, sp. nov.	BL, BO, LB, PO, TP	B	A	15–17	1 laterally (slight) / C	1	semicircular with scales anteriorly; short, smooth ridge posteriorly	2–3 and 6–14/ *11–14*	P	greatly reduced	folded, long hook or straight, blunt	2–3 and 6–14
P. vittatus, sp. nov.	BL (trace), BO, LB, PO, TP (TP juvenile only)	NB	A	5–6	not enlarged	up to 2	short, smooth ridge	2–3 and 6–14/ *11–14*	P	greatly reduced	folded, long hook	6–14

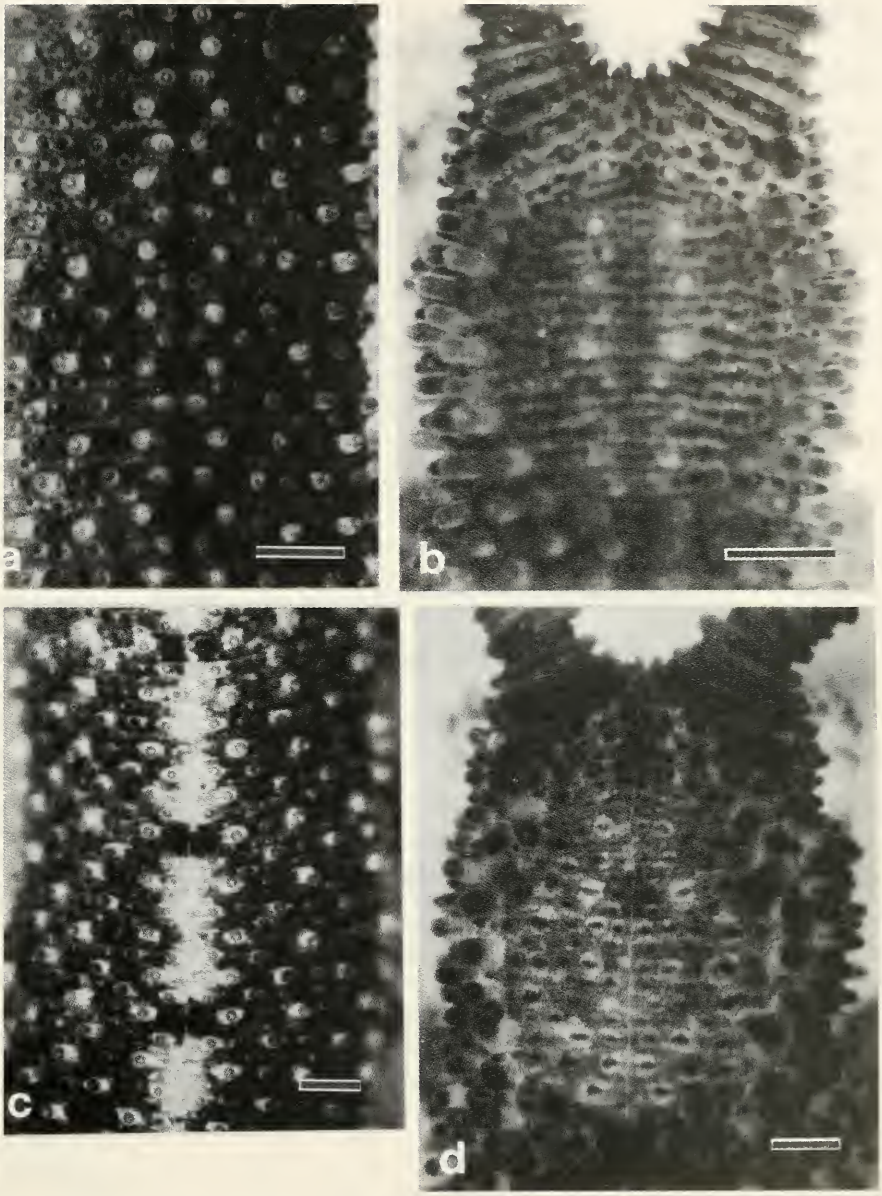

Figure 1. *Planipapillus annae*, sp. nov.: (a) body, holotype male 0.90 mm HWE, scale bar 0.30 mm; (b) head, holotype male, 0.90 mm HWE, scale bar 0.30 mm. *Planipapillus berti,* sp. nov.: (c) body, paratype male, 0.85 mm HWE, scale bar 0.20 mm; (d) head, paratype male, 0.87 mm HWE, scale bar 0.20 mm.

rows plicae; papillae forming patch triangular, ridge-like; papillar scales fused, papillae smooth, each with a sensory bristle. Papillae laterally and posteriorly adjacent to patch cylindrical, enlarged; 2–3 rows of enlarged papillae laterally, enlarged papillae all similar length, innermost row only slightly longer than rest; four enlarged papillae in single transverse row posterior to patch; each enlarged papilla with single bristle (Figs 1b and 3).

Head (females)

Females with no modification of head papillae.

Dorsal integument

Males with 12–12–13, females with 12–13–14 papillae counted from mid-dorsal line to junction of oncopod 10. Primary papillae cylindrical.

Male reproductive tract

Male genital pad cylindrical, protuberant. Proximal vasa efferentia separate, do not lie parallel before fusing to form vas deferens; vas deferens continues directly (without looping) from paired vasa efferentia to gonopore (Fig. 4a).

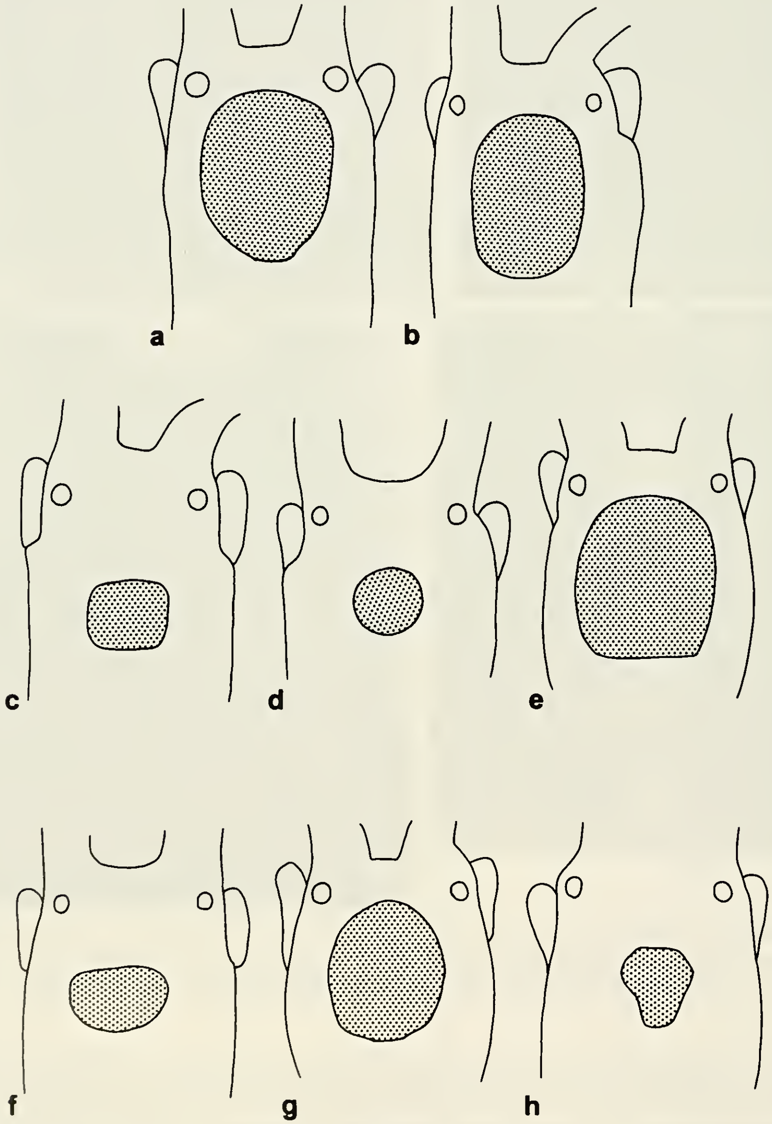

Figure 2. *Planipapillus*, spp. nov. diagrams of male heads to show relative positions of patches of modified papillae (shaded): (a) *P. annae*, sp. nov.; (b) *P. berti*, sp. nov.; (c) *P. biacinoides*, sp. nov.; (d) *P. cyclus*, sp. nov.; (e) *P. gracilis*, sp. nov.; (f) *P. impacris*, sp. nov.; (g) *P. tectus*, sp. nov.; (h) *P. vittatus*, sp. nov.

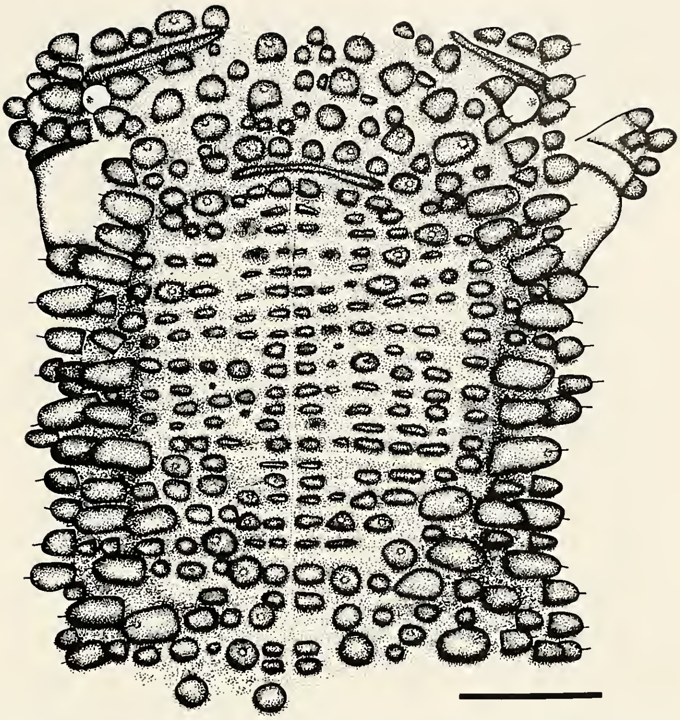

Figure 3. *Planipapillus annae,* sp. nov., modified region of head, holotype male, 0.90 mm HWE, scale bar 0.30 mm.

Male glands and gland papillae

Crural papillae on ventral side of oncopods 2–3 and 6–14. Papillae shape differs among oncopods: semicircular or cylindrical proximally, tapered abruptly to narrower, semicircular or cylindrical distal section (oncopods 2–3) or semicircular or cylindrical, tapered slightly distally, not divided into distinct basal and distal regions (oncopods 6–14); papillae oncopods 6–10 narrow, low, cylindrical. Crural glands extend into lateral haemocoel from oncopods 11–14; straight, short, not folded; remaining glands confined within oncopods. Anterior accessory gland papillae absent. Anterior accessory glands absent. Posterior accessory glands straight, bulbous, blunt distally (Fig. 5a), or folded distally, short hook tapered only slightly to blunt tip (Fig. 5b).

Female crural papillae

Absent.

Remarks

Planipapillus annae, sp. nov. differs from most other species that do not have spikes on the posterior margin of the head patch in lacking the pale mid-dorsal longitudinal light-coloured band that is very distinctive in many members of this genus. While some *P. mundus* and *P. gracilis*, sp. nov. specimens also lack this band, *P. mundus* does not have dark mid-dorsal blotches dorsal to each oncopod, and has banded antennae, unlike *P. annae,* sp. nov. *Planipapillus gracilis*, sp. nov. differs in having up to three sensory bristles on the enlarged papillae lateral to the male head patch. The papillae on each side of the head patch are not as elongate in *P. annae*, sp. nov. as they are in *P. berti*, sp. nov. and *P. gracilis*, sp. nov., and are of similar length, while those of the latter two species vary in length. Additional characters that distinguish this species from other members of the genus are shown in Figs 2, 5 and Table 1.

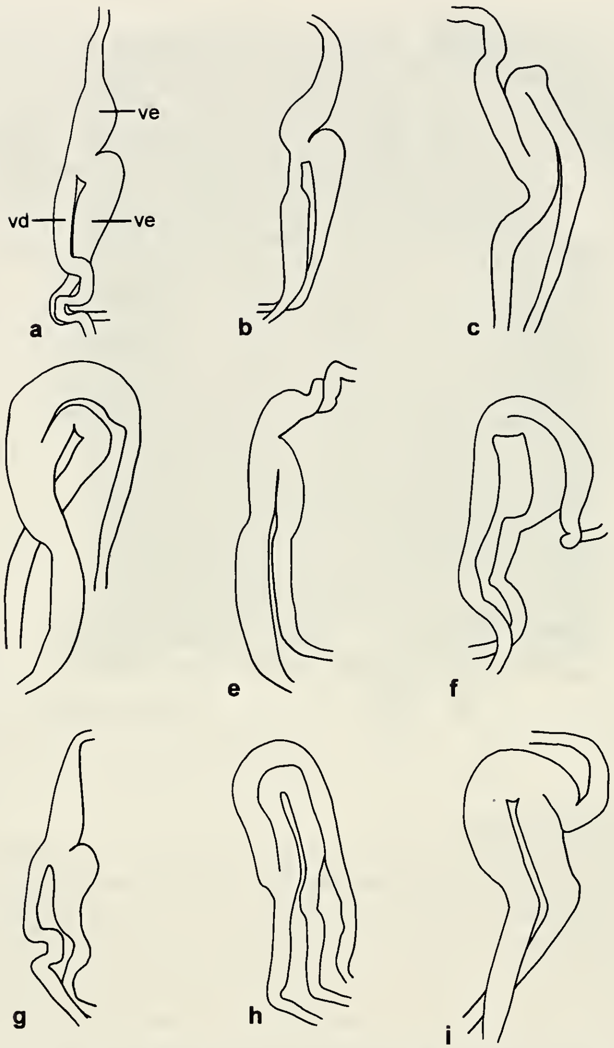

Figure 4. *Planipapillus,* spp. nov. posterior section of male reproductive tracts showing vas deferens and part of vasa efferentia for comparison: (a) *P. annae,* sp. nov., vd, vas deferens, ve, vasa efferentia, n=6, scale bar 0.50 mm; (b) *P. berti,* sp. nov., n=12, scale bar 0.50 mm; (c) *P. biacinoides,* sp. nov., n=2 (in addition, one specimen with tracts similar in appearance to *P. impacris,* sp. nov., Fig. 4f), scale bar 0.30 mm; (d) *P. cyclus,* sp. nov., n=3, scale bar 0.30 mm; (e) *P. gracilis,* sp. nov., n=4, scale bar 0.30 mm; (f) *P. impacris,* sp. nov., n=2 (in addition one specimen with tracts similar in appearance to *P. tectus,* sp. nov., Fig. 4g), scale bar 0.50 mm; (g) *P. tectus,* sp. nov., n=4, scale bar 0.50 mm; (h) *P. vittatus,* sp. nov., n=1, scale bar 0.50 mm; (i) *P. vittatus,* sp. nov, n=2, scale bar 0.30 mm. n, number of male reproductive tracts examined exhibiting the illustrated shape.

When specimens were being prepared for preservation following collection, two specimens were observed presumably mating. The head of a male specimen was attached to the genital opening of a female specimen and both walked around in this position for some time. The tip of the ovipositor of the female was positioned on the patch of reduced papillae on the male's head and the elongate papillae on each side of the patch clasped the ovipositor. The female was not subsequently checked for the presence of sperm in the genital tract to determine whether insemination had taken place. 'Head-to-tail' mating has been observed in only one other species of onychophoran to date (Meredith 1995 and Tait pers. comm.).

Habitat

In and under logs in dry sclerophyll woodland. Specimens were collected beside road in cleared farming area (Fig. 6). Live, hand collected specimens were usually coiled in spiral when first exposed.

Distribution

This species is known only from the type locality (Fig. 7).

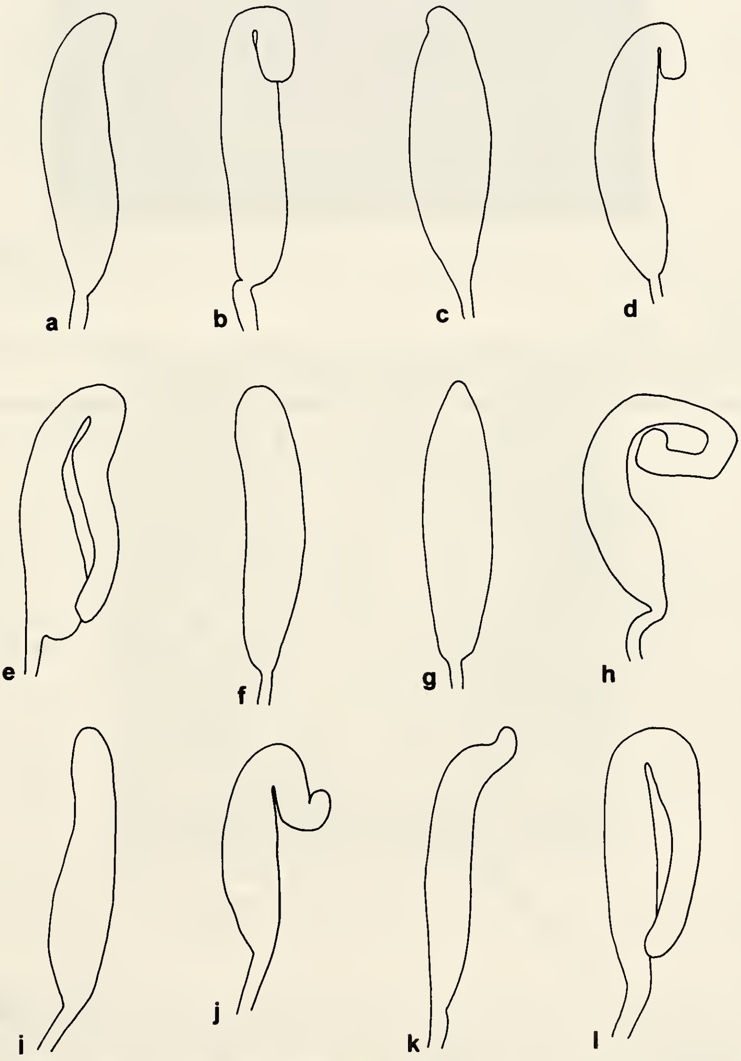

Figure 5. *Planipapillus,* spp. nov. posterior accessory glands: (a) *P. annae,* sp. nov., n=5, scale bar 0.30 mm; (b) *P. annae,* sp. nov., n=7, scale bar 0.30 mm; (c) *P. berti*, sp. nov., n=24, scale bar 0.20 mm; (d) *P. biacinoides*, sp. nov., n=6, scale bar 0.30 mm; (e) *P. cyclus*, sp. nov., n=6, scale bar 0.40 mm; (f) *P. gracilis*, sp. nov., n=7, scale bar 0.20 mm; (g) *P. gracilis*, sp. nov., n=1, scale bar 0.20 mm; (h) *P. impacris*, sp. nov., n=6, scale bar 0.50 mm; (i) *P. tectus*, sp. nov., n=6, scale bar 0.30 mm; (j) *P. tectus*, sp. nov., n=1, scale bar 0.30 mm; (k) *P. tectus*, sp. nov., n=1, scale bar 0.30 mm; (l) *P. vittatus*, sp. nov., n=5, scale bar 0.20 mm. n, number of glands examined exhibiting the illustrated shape. (Where two glands are shown for a species, individuals may have one of each type.)

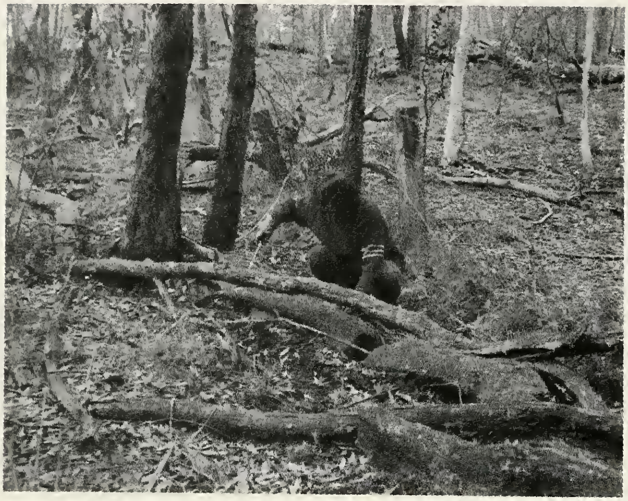

Figure 6. Type locality of *Planipapillus annae*, sp. nov., beside Gelantipy Rd. between Bonang and Tubbut, Victoria. Anne Skates (after whom the species is named) is searching fallen timber for specimens.

Etymology

This species is named in honour of Anne Skates, who found the first specimen and has accompanied me on many fieldtrips in search of Onychophora.

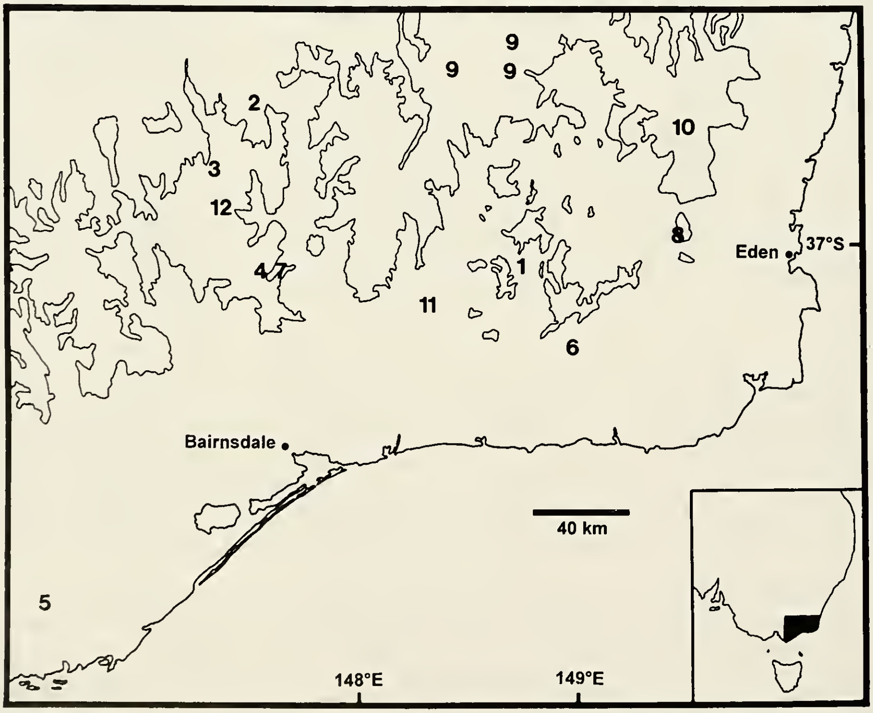

Figure 7. Distributions of *Planipapillus* spp.: (1) *P. annae,* sp. nov.; (2) *P. berti*, sp. nov.; (3) *P. biacinaces* Reid, 1996; (4) *P. biacinoides*, sp. nov.; (5) *P. bulgensis* Reid, 1996; (6) *P. cyclus*, sp. nov.; (7) *P. gracilis*, sp. nov.; (8) *P. impacris*, sp. nov.; (9) *P. mundus*, Reid, 1996; (10) *P. taylori* Reid, 1996; (11) *P. tectus*, sp. nov.; (12) *P. vittatus*, sp. nov. 1,000 m contour shown. Note: Specimens of *P. biacinaces* have now been found at Falls Creek. They were previously only known from the type locality, Howman Gap, Victoria.

Planipapillus berti, sp. nov.

(Figures 1c; 1d; 2b; 4b; 5c; 7; 8; 9. Table 1)

Material examined

Holotype: ♂ Victoria, Granite Flat, 9 km S of Mitta Mitta, beside Omeo Hwy, N of intersection of Omeo Hwy and Walsh's Rd, 36°35'S 147°27'E, 350 m, 9 Mar 1999, coll. A. Reid and R. Roberts (MV K7283).

Paratypes: Victoria, 12♂ 3♀, data as for holotype (MV K7284).

Diagnosis

Body with longitudinal light-coloured band along dorsal midline and dark bands or blotches dorsal to oncopods; antennae banded. Ovoid patch of reduced papillae on the heads of males without sclerotised spikes; 18–22 rows of plicae comprise patch; 1–2 rows of papillae lateral to patch elongate, finger-like, each with up to three sensory bristles. Anterior accessory glands absent and gland papillae usually absent. Posterior accessory glands straight, blunt.

Description

Measurements

HWE males 0.80–0.87–0.97 mm (n=13, Holotype 0.97 mm HWE); HWE females 0.87–0.88–0.90 mm (n=3).

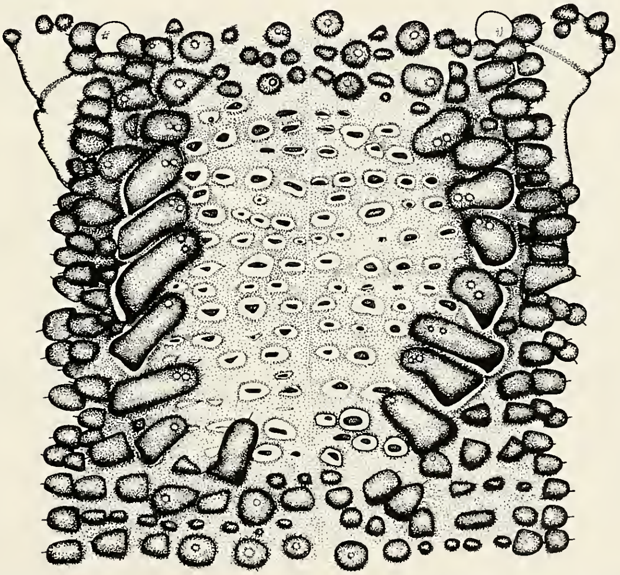

Figure 8. *Planipapillus berti,* sp. nov., modified region of head, holotype male, 0.97 mm HWE, scale bar 0.20 mm.

Colour pattern

Ground colour greyish-blue (few specimens brownish). Mid-dorsal dark stripe absent; longitudinal light-coloured band along dorsal midline and short, dark, transverse bars or blotches along midline dorsal to oncopods [band light ground colour, or, in two of 16 specimens, tan (Fig. 1c)]; laterally with distinctive cream patches between oncopods. Oncopods with light patches at junction with feet. Papillae around anal opening pigmented as for rest of body, or sometimes pale yellow. Ventral pigment present, very pale ground colour. Spinous pads pale yellow, or greyish-blue. Integument between genital and anal openings pigmented as for rest of ventrum.

Antennal rings banded, tan or with tan mottle dorsally; dorsal banding on alternate rings distal to, and including ring five (very pale, mottling on basal third of antennae only).

Antennal rings

Distal 8–9 antennal rings with sensory bulbs; sensory pads with two rows of sensilla.

Eyes

EDI males 0.06–0.07–0.10; EDI females 0.07–0.08–0.08.

Head (males)

Males with modified papillae on head (i.e. differ from remaining dorsal papillae). Papillae reduced in longitudinal ovoid patch posterior to eyes (Fig. 2b). Patch without sclerotised spikes at medio-posterior margin. Ovoid patch comprising 18–22 rows plicae; papillae forming patch triangular, ridge-like (with 8–10 reduced papillae on each plica); papillar scales fused, papillae smooth, each with a sensory bristle. Papillae laterally adjacent to patch cylindrical, finger-like, enlarged; 1–2 rows of enlarged papillae, inner row longest with 7–10 papillae; long and shorter papillae alternate in length from anterior to posterior; each enlarged papilla with up to three bristles (usually 1–2) (Figs 1d and 8).

Head (females)

Females with no modification of head papillae.

Dorsal integument

Males with 12–12–14, females with 11–12–14 papillae counted from mid-dorsal line to junction of oncopod 10. Primary papillae cylindrical.

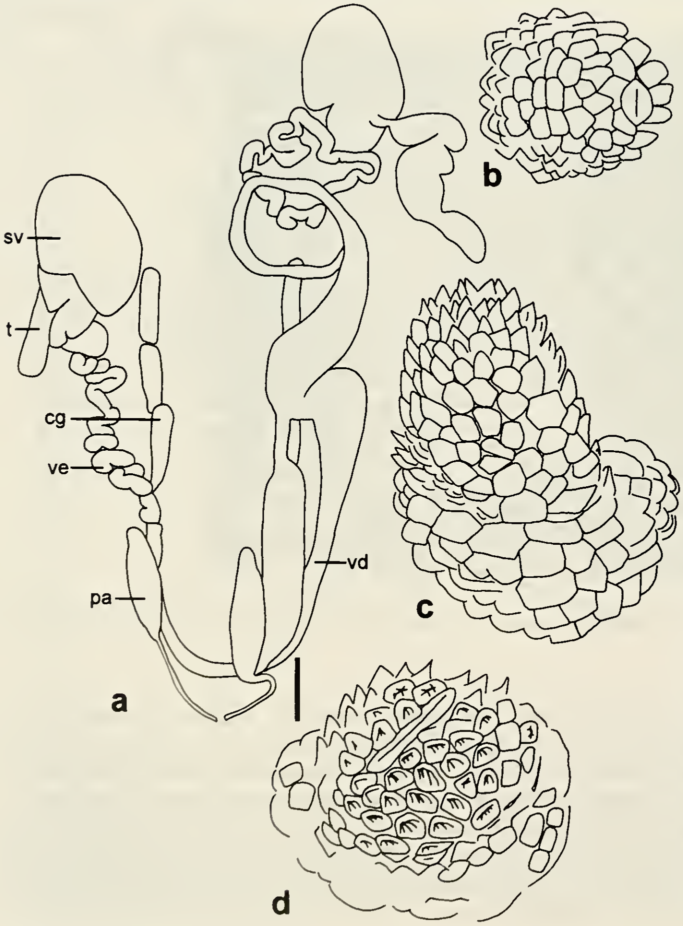

Figure 9. *Planipapillus berti,* sp. nov.: (a) male reproductive tract and associated glands, paratype, 0.87 mm HWE, scale bar 0.50 mm; (b) distal tip of crural papilla oncopod 3, paratype male, 0.85 mm HWE, scale bar 0.03 mm; (c) crural papilla oncopod 3, side view, paratype male, 0.85 mm HWE, scale bar 0.02 mm; (d) crural papilla oncopod 12, paratype male 0.85 mm HWE, scale bar 0.05 mm. cg, crural gland; pa, posterior accessory gland; sv, seminal vesicle; t, testis; vd, vas deferens; ve, vas efferens.

Male reproductive tract

Proximal vasa efferentia separate, do not lie parallel before fusing to form vas deferens; vas deferens continues directly (without looping) from paired vasa efferentia to gonopore (Figs 4b and 9a).

Male glands and gland papillae

Crural papillae on ventral side of oncopods 2–3 and 6–14. Papillae shape differs among oncopods: semicircular or cylindrical proximally, tapered abruptly to narrower, semicircular or cylindrical distal section [oncopods 2–3 (Figs 9b and 9c)], or semicircular or cylindrical, tapered slightly distally, not divided into distinct basal and distal regions [oncopods 6–14 (Fig. 9d)]. Crural papillae oncopods 2–3 large; crural papillae small on oncopods 6–9, 10 or 11 (variable); remaining crural papillae large. Crural glands extend into lateral haemocoel from oncopods 11–14; straight, short, not folded (Fig. 9a); remaining glands confined within oncopods. Anterior accessory gland papillae usually absent. Anterior accessory glands absent. Posterior accessory glands straight, tapered to blunt point distally (Figs 5c and 9a).

Female crural papillae

Absent.

Remarks

The papillae lateral to the head patch in male *Planipapillus berti*, sp. nov. are much longer than those in all other species, with the exception of *P. gracilis*, sp. nov. *Planipapillus berti*, sp. nov. differs from *P. gracilis*, sp. nov. in having a longitudinal light-coloured band along the dorsal midline. Additional characters that distinguish *P. berti*, sp. nov. from other *Planipapillus* are given in Figs 2, 5 and Table 1.

Usually a greater number of female than male *Planipapillus* are found at a collection site, suggesting a sex ratio biased towards females in *Planipapillus* populations. At Granite Flat, the converse was true; 14 of a total of 20 specimens collected were male. Whether this ratio is a true representation for the entire population is unknown.

A single male specimen had an anterior accessory gland papilla (but without a corresponding anterior accessory gland) on one of the last oncopods.

Planipapillus berti, sp. nov. was found with two male *Ooperipatus* sp.

Habitat

In and under logs in dry sclerophyll woodland. Live, hand collected specimens were usually coiled in spiral when first exposed.

Distribution

The species is known only from the type locality (Fig. 7).

Etymology

The species is named in honour of the author's husband Richard (Bert) Roberts who collected the first specimens and has become quite expert in the collection of Onychophora.

Planipapillus biacinoides, sp. nov.

(Figures 2c; 4c; 5d; 7; 10a; 10b; 10c; 11. Table 1)

Material examined

Holotype: ♂, Victoria, beside Livingstone Ck at intersection of Birregun Rd and Upper Livingstone Tk (6.2 km S of intersection of Cassilis Rd and Birregun Rd), 37°05'S 147°36'E, 300 m, 13 Mar 1999, coll. A. Reid and R. Roberts (MV K7285).

Paratypes: Victoria, 2♂ 1♀, data as for holotype (MV K7286).

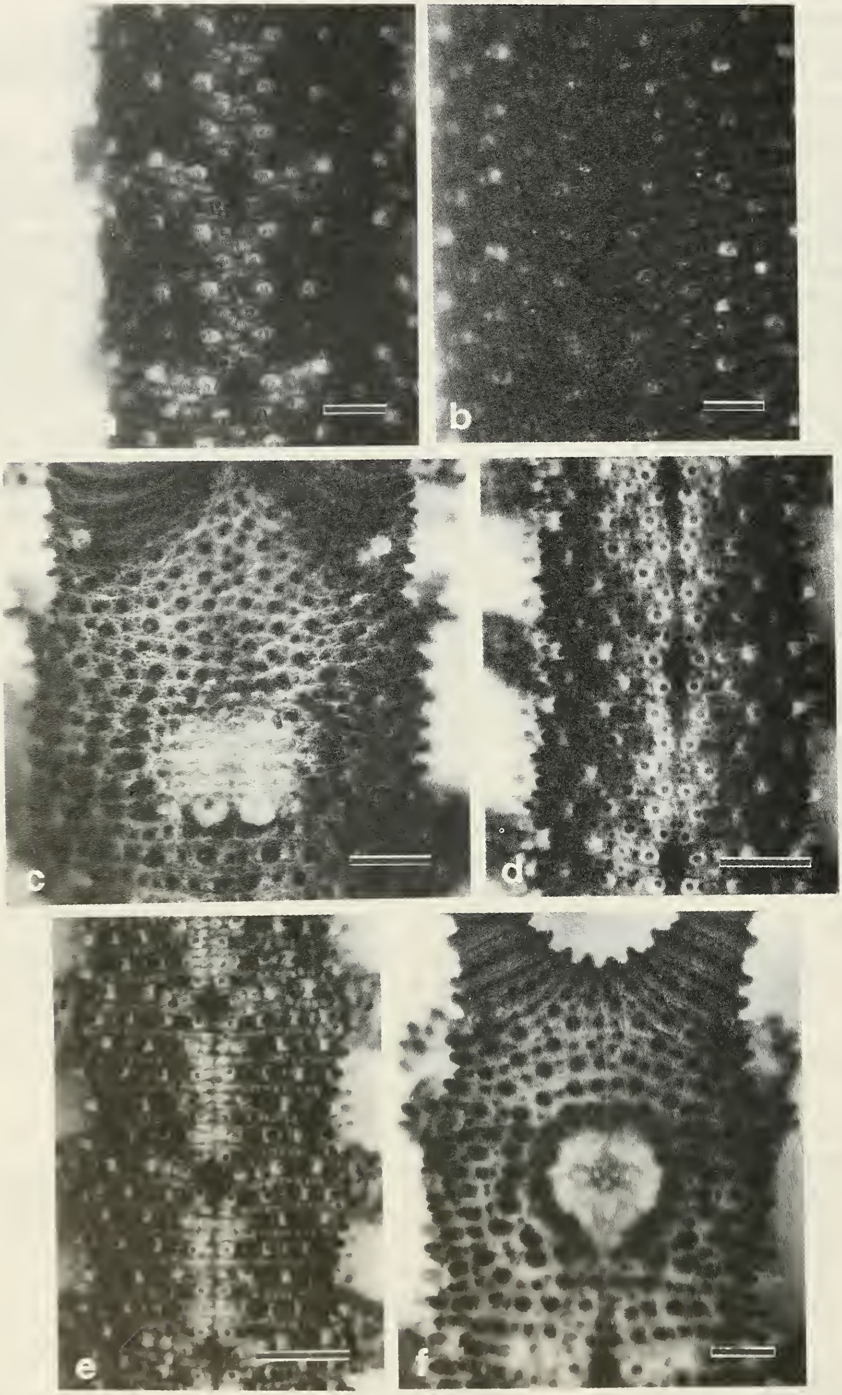

Figure 10. *Planipapillus biacinoides*, sp. nov.: (a) body, paratype male, 0.75 mm HWE, scale bar 0.30 mm; (b) body, holotype male, 1.12 mm HWE, scale bar 0.30 mm; (c) head, holotype male, 1.12 mm HWE, scale bar 0.30 mm. *Planipapillus cyclus*, sp. nov.: (d) body, holotype male, 0.82 mm HWE, scale bar 0.50 mm; (e) body, paratype female, 0.85 mm HWE, scale bar 0.50 mm; (f) head, holotype male, 0.82 mm HWE, scale bar 0.20 mm.

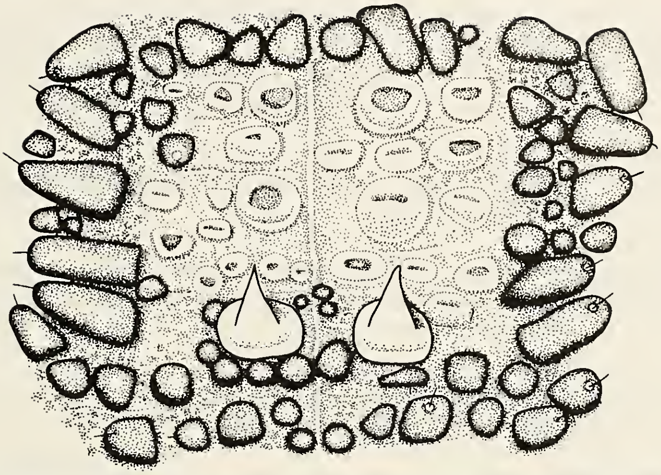

Figure 11. *Planipapillus biacinoides*, sp. nov., modified region of head, holotype male, 1.12 mm HWE, scale bar 0.20 mm.

Diagnosis

Antennae without tan banding on and between antennal rings 3–4. Ovoid patch of reduced papillae in males with two sclerotised spikes at posterior margin; plicae in 6–7 rows comprise patch; papillae enlarged on each side of patch, each with single sensory bristle. Crural papillae present in both sexes. Posterior accessory glands folded, with short hook distally.

Description

Measurements

HWE males 0.75–0.98–1.12 mm (n=3, Holotype 1.12 mm HWE); HWE female 0.80 mm.

Colour pattern

Ground colour greyish-blue. Mid-dorsal dark stripe absent; longitudinal light-coloured band (usually tan) along dorsal midline and short, dark, transverse bars or blotches along midline dorsal to oncopods (Fig. 10a) [not visible in dark specimens (Fig. 10b)]; light dorsolateral ovoid patches in line with oncopods [in small specimens only (Fig. 10a)]; laterally with light patches between oncopods (indistinct, some tan-based papillae). Oncopods with light patches at junction with feet. Papillae around anal opening pigmented as for rest of body. Ventral pigment present, very pale. Spinous pads greyish-blue. Integument between genital and anal openings pigmented as for rest of ventrum, or darker than rest of ventrum.

Antennal rings banded, tan or with tan mottle dorsally, or not banded, ground colour; dorsal banding on alternate rings distal to, and including ring five.

Antennal rings

Distal eight antennal rings with sensory bulbs; sensory pads with 2–3 rows of sensilla (two in small specimens).

Eyes

EDI males 0.07–0.08–0.08. EDI females 0.06.

Head (males)

Males with modified papillae on head (i.e. differ from remaining dorsal papillae). Papillae reduced in an ovoid-squarish patch posterior to eyes (Fig. 2c). Patch with two short, sclerotised spikes at posterior margin (Figs 10c and 11). Ovoid patch comprising 6–7 rows of plicae; papillae forming patch blunt conical; papillar scales fused, papillae smooth, each with a sensory bristle. Papillae laterally adjacent to patch cylindrical, enlarged; 2–3 rows enlarged papillae, innermost row only slightly longer than rest; each enlarged papilla with single bristle.

Head (females)

Females with no modification of head papillae.

Dorsal integument

Males and females with 12 papillae counted from mid-dorsal line to junction of oncopod 10. Primary papillae cylindrical.

Male reproductive tract

Male genital pad low, conical. Proximal vasa efferentia separate, do not lie parallel before fusing to form vas deferens; vas deferens continues directly (without looping) from paired vasa efferentia to gonopore (Fig. 4c).

Male glands and gland papillae

Crural papillae on ventral side of oncopods 2–3 and 6–14. Papillae shape differs among oncopods: semicircular or cylindrical proximally, tapered abruptly to narrower, semicircular or cylindrical distal section (oncopods 2–3 and 6–10) or subconical, not divided into distinct basal and distal regions (oncopods 11–14). Crural glands extend into lateral haemocoel from oncopods 11–14; straight, short, not folded; remaining glands confined within oncopods. Anterior accessory gland papillae present; large, semicircular. Anterior accessory glands present; greatly reduced. Posterior accessory glands folded distally, short blunt hook (Fig. 5d).

Female crural papillae

Present (very small papillae visible on some oncopods, see Remarks).

Remarks

Planipapillus biacinoides, sp. nov. is very similar to *P. biacinaces*. The pigmentation of the two species differs. *Planipapillus biacinaces* specimens have a distinctive broad tan band at the base of each antenna, on and between the third and fourth antennal rings; this trait is not seen in *P. biacinoides*, sp. nov. This character was not mentioned in the original description of *P. biacinaces*, but was discovered when comparing *P. biacinaces* with the species described here. Six to seven plicae comprise the male head patch in *P. biacinoides,* sp. nov., while 10–11 plicae comprise this patch in *P. biacinaces. Planipapillus biacinoides,* sp. nov. differs from all other *Planipapillus* (with the exception of *P. biacinaces*) in having two sclerotised spikes at the posterior margin of the male head patch. Other differences are shown in Figs 2, 5 and Table 1.

This species was found with *P. gracilis*, sp. nov. While other sympatric peripatopsids are known, in all cases to date where one or more species have been collected at a site, they have belonged to different genera. For example, *Planipapillus* species often occur with *Ooperipatus*. This is the first time, within Australia that representatives of the same genus have been found together. The heads of males of the two species are distinctly different (compare Figs 10c and 13c), but it is difficult to determine to which species females collected at the site belong. Four females were collected at the site. One of these was very small, but appeared to have crural papillae on some of the oncopods. Female *P. biacinaces* are now known to have crural papillae on some of the oncopods, so it is highly likely that they also occur in female *P. biacinoides,* sp. nov. The three larger females that lacked crural papillae have therefore been assigned to *P. gracilis*, sp. nov. When more, particularly mature, females are collected, this inference can be verified. In addition, the three larger females had a greater number of papillae counted from the mid-dorsal line to the junction of oncopod 10 (20–22 in *P. gracilis,* sp. nov. and only 12 in *P. biacinoides,* sp. nov.). Whether this is significant, or simply the result of small versus large females being compared is yet to be determined. No other morphological characters could be found to distinguish the females of the two species but molecular characters may provide additional clues.

Habitat

In and under logs in dry sclerophyll woodland. Specimens were collected beside road in cleared farming area (Fig. 6). Live, hand collected specimens were usually coiled in spiral when first exposed.

Distribution

This species is known only from the type locality (Fig. 7).

Etymology

The similarity between this species and *P. biacinaces* is reflected in the species name that is based on *biacinaces* with the termination '-oides', meaning 'like', or 'resembling the form of'.

Planipapillus cyclus, sp. nov.

(Figures 2d; 4d; 5e; 7; 10d; 10e; 10f; 12. Table 1)

Material examined

Holotype: ♂, Victoria, 9 km N of Club Terrace, junction of Errinundra Rd and Combienbar Rd, 37°28'S 148°55'E, 130 m, 16 Jun 1999, coll. A. Reid and A. Skates (MV K7287).

Paratypes: Victoria, 2♂, 2♀, data as for holotype (MV K7288).

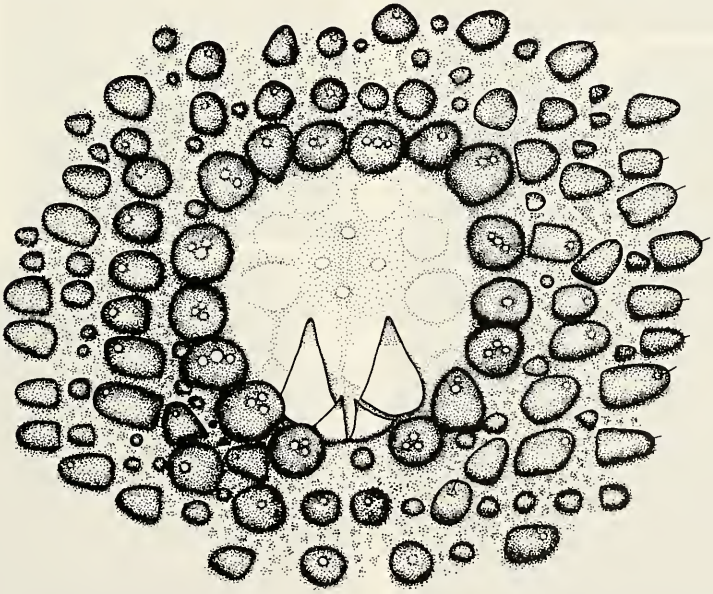

Figure 12. *Planipapillus cyclus*, sp. nov., modified region of head, holotype male, 0.82 mm HWE, scale bar 0.20 mm.

Diagnosis

Circular patch of reduced papillae posterior to eyes in males with four subequal spikes on the posterior margin; patch surrounded by single row of enlarged semicircular papillae, each with up to four sensory bristles. Crural papillae on oncopods 2–3 and 6–14 in both sexes. Anterior accessory glands present in males, short.

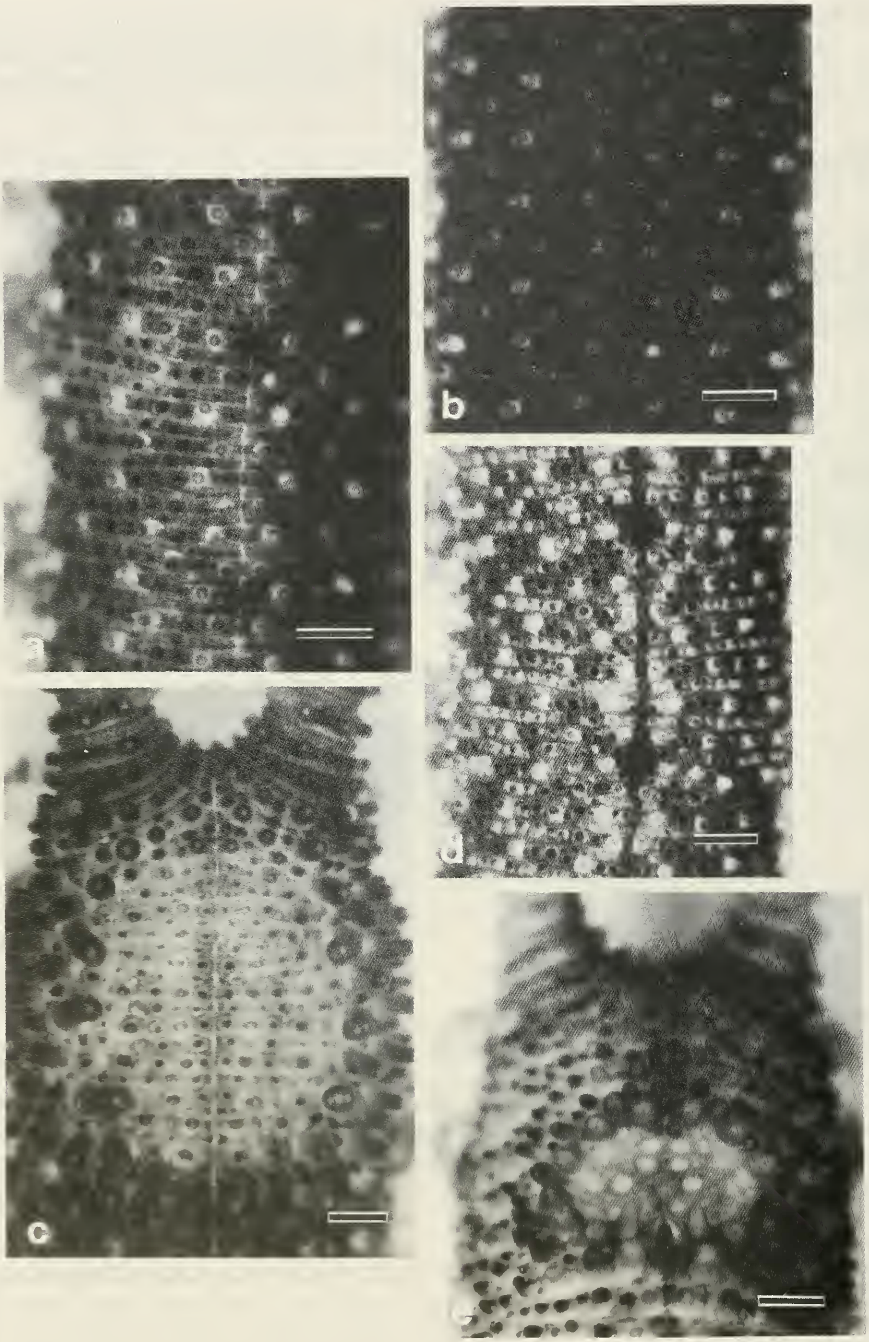

Figure 13. *Planipapillus gracilis*, sp. nov.: (a) body, paratype male, 0.92 mm HWE, scale bar 0.30 mm; (b) body, holotype male, 0.95 mm HWE, scale bar 0.30 mm; (c) head, holotype male, 0.95 mm HWE, scale bar 0.20 mm. *Planipapillus impacris*, sp. nov.: (d) body, paratype female, 1.20 mm HWE, scale bar 0.50 mm; (e) head, holotype male, 1.12 mm HWE, scale bar 0.25 mm.

Description

Measurements

HWE males 0.77–0.80–0.82 mm (n=3, Holotype 0.82 mm HWE); HWE; females 0.85–0.88–0.92 mm (n=2).

Colour pattern

Ground colour tan, brown or greyish-blue. Mid-dorsal dark stripe present (narrow); longitudinal pale ground-coloured band along dorsal midline (Figs 10d and 10e), short, dark, transverse bars, longitudinal bars, or blotches along midline dorsal to oncopods, and laterally with longitudinal light band dorsal to oncopods. Oncopods with light patches at junction with feet. Papillae around anal opening pigmented as for rest of body, or tan. Ventral pigment pale; mottled with darker patches at oncopod bases. Spinous pads tan, or greyish-blue. Integument between genital and anal openings pigmented as for rest of ventrum, or tan (in greyish-blue specimens).

Antennal rings banded, tan or with tan mottle dorsally, or not banded, ground colour; dorsal banding on alternate rings distal to, and including ring five (for three quarters of antennal length).

Antennal rings

Uniform width; distal seven antennal rings with sensory bulbs; sensory pads with 2–3 rows of sensilla.

Eyes

EDI males 0.08–0.08–0.09; EDI females 0.07–0.07–0.08.

Head (males)

Males with modified papillae on head (i.e. differ from remaining dorsal papillae). Papillae reduced in circular patch posterior to eyes (Figs 2d and 10f). Patch with four sclerotised spikes at medio-posterior margin; median pair much smaller than lateral pair, positioned posterior to large spikes (Fig. 12). Ovoid patch comprising 6–7 rows of plicae; papillae forming patch greatly reduced, or absent; papillar scales fused, papillae smooth, median bristles absent. Papillae adjacent to patch semicircular, enlarged; single row of enlarged papillae forming circle, with gap posterior to spikes (Fig. 12); each enlarged papilla with up to four bristles.

Head (females)

Females with no modification of head papillae.

Dorsal integument

Males with 12–13–14, females with 13 papillae counted from mid-dorsal line to junction of oncopod 10. Primary papillae cylindrical.

Male reproductive tract

Proximal vasa efferentia lying close together, parallel for part of their length before fusing to form vas deferens; vas deferens continues directly (without looping) from paired vasa efferentia to gonopore (Fig. 4d).

Male glands and gland papillae

Crural papillae on ventral side of oncopods 2–3 and 6–14. Papillae similar in shape on all oncopods: semicircular or cylindrical proximally, tapered abruptly to narrower, semicircular or cylindrical distal section. Crural glands extend into lateral haemocoel from oncopods 6–14; straight, short, not folded; remaining glands confined within oncopods. Anterior accessory gland papillae present; semicircular. Anterior accessory glands present; short. Posterior accessory glands folded distally, long hook tapered only slightly to blunt tip (Fig. 5e).

Female crural papillae

Present on oncopods 2–3 and 6–14.

Remarks

Planipapillus impacris, sp. nov. males also have four spikes (one large and one small pair) on the posterior margin of the head patch. The head patch is much larger in *P. impacris*, sp. nov. than in *P. cyclus*, sp. nov., and is oval, rather than circular in shape. The papillae surrounding the patch are enlarged to a greater extent in *P. impacris*, sp. nov. than in *P. cyclus*, sp. nov., and the spikes at the posterior margin of the patch are larger (compare Figs 12 and 15). Additional characters distinguishing these two species and other *Planipapillus* species are shown in Figs 2, 5 and Table 1.

Habitat

The type specimens were found in a log in wet sclerophyll forest. Live, hand collected specimens were usually coiled in spiral when first exposed, the head is tucked in the loop of the body.

Distribution

This species is known only from the type locality (Fig. 7).

Etymology

The species name is Latin and means ‘circle’, or ‘ring’. It refers to the shape of the patch of reduced papillae, surrounded by a prominent ring of papillae on the heads of males in this species.

Planipapillus gracilis, sp. nov.

(Figures 2e; 4e; 5f; 5g; 7; 13a; 13b; 13c; 14. Table 1)

Material examined

Holotype: ♂, Victoria, beside Livingstone Ck at intersection of Birregun Rd and Upper Livingstone Tk (6.2 km S of intersection of Cassilis Rd and Birregun Rd), 37°05’S 147°36’E, 300 m, 13 Mar 1999, coll. A. Reid and R. Roberts (MV K7289).

Paratypes: Victoria, 3♂, 3♀, data as for holotype (MV K7290).

Diagnosis

Body without median longitudinal light-coloured band. Ovoid patch of reduced papillae on the heads of males without sclerotised spikes; 19–20 rows of plicae comprise patch; 1–2 rows of papillae lateral to patch elongate, finger-like with up to three sensory bristles. Anterior accessory glands absent and gland papillae usually absent. Posterior accessory glands straight, blunt, or tapered to a blunt point distally.

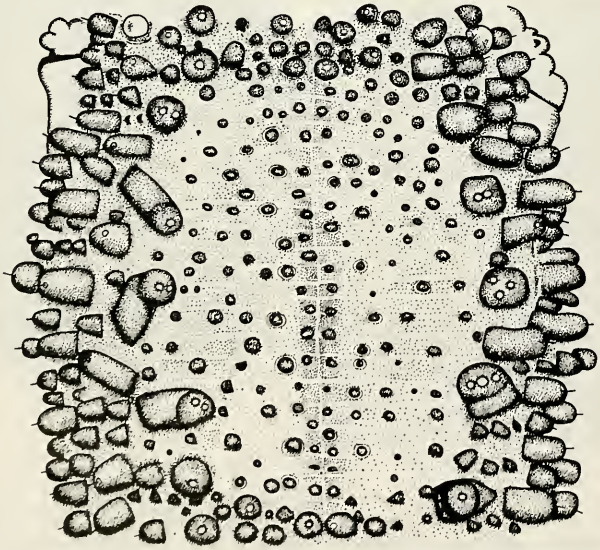

Figure 14. *Planipapillus gracilis*, sp. nov., modified region of head, holotype male, 0.95 mm HWE, scale bar 0.25 mm.

Description

Measurements

HWE males 0.90–0.94–1.00 mm (n=4, Holotype 0.95 mm HWE); HWE females 1.07–1.12–1.17 (n=3).

Colour pattern

Ground colour dark greyish-blue. Mid-dorsal dark stripe absent (Figs 13a and 13b); without median longitudinal light-coloured band; with short, dark, transverse bars or blotches along midline, dorsal to oncopods [trace only visible in dark specimens (Fig. 13b)]; laterally with light patches between oncopods (distinctive). Oncopods with cream patches at junction with feet. Papillae around anal opening pigmented as for rest of body. Ventral pigment present; lighter than dorsum. Spinous pads greyish-blue. Integument between genital and anal openings darker than rest of ventrum.

Antennal rings banded, tan or with tan mottle dorsally, or not banded, ground colour.

Antennal rings

Distal 8–9 antennal rings with sensory bulbs; sensory pads with 1–2 rows of sensilla.

Eyes

EDI males 0.05–0.06–0.06; EDI females 0.05–0.06–0.07.

Head (males)

Males with modified papillae on head (i.e. differ from remaining dorsal papillae). Papillae reduced in longitudinal ovoid patch posterior to eyes (Figs 2e and 13c). Patch without sclerotised spikes at medio-posterior margin. Ovoid patch comprising 19–20 rows of plicae; papillae forming patch triangular, ridge-like; papillar scales fused, papillae smooth, each with a sensory bristle. Papillae laterally and posteriorly adjacent to patch cylindrical, enlarged; 1–2 rows of enlarged papillae laterally, inner row longest, long and shorter papillae alternate in length from anterior to posterior (Fig. 13c and 14); single row of enlarged papillae posterior to patch; each enlarged papilla with up to three bristles.

Head (females)

Females with no modification of head papillae.

Dorsal integument

Males with 12 papillae counted from mid-dorsal line to junction of oncopod 10, females with 20–22–22 papillae counted from mid-dorsal line to junction of oncopod 10. Primary papillae cylindrical.

Male reproductive tract

Proximal vasa efferentia separate, do not lie parallel before fusing to form vas deferens; vas deferens continues directly (without looping) from paired vasa efferentia to gonopore (Fig. 4e).

Male glands and gland papillae

Crural papillae on ventral side of oncopods 2–3 and 6–14 (papillae on oncopods 6–7 reduced). Papillae shape differs among oncopods: semicircular or cylindrical proximally, tapered abruptly to narrower, semicircular or cylindrical distal section (oncopods 2–3 and 6–9) or subconical, not divided into distinct basal and distal regions (oncopods 10–14). Crural glands extend into lateral haemocoel from oncopods 11–14; straight, short, not folded; remaining glands confined within oncopods. Anterior accessory gland papillae absent (usually). Anterior accessory glands absent. Posterior accessory glands usually straight, blunt (Fig. 5f), or tapered to blunt point distally (Fig. 5g).

Female crural papillae

Absent.

Remarks

The holotype has very reduced anterior accessory papillae on the last oncopod pair, but these papillae are not visible on other material examined.

The females (collected in March 1999) contained thick-shelled eggs in the oviducts. Among *Planipapillus* males that lack spikes at the posterior margin of a large head patch, *P. gracilis*, sp. nov. is most similar to *P. berti*. Differences between these two species are given in the Remarks section of *P. berti*. It differs from *P. annae*, *P. bulgensis* and *P. mundus* in having up to three sensory bristles on the enlarged papillae, rather than one on each papilla. The size of the male head patch and elongate papillae surrounding the patch distinguish *P. gracilis*, sp. nov. from *P. bulgensis*. The papillae on each side of the patch are much more elongate in *P. gracilis*, sp. nov. than they are in *P. annae* and *P. bulgensis*. Additional characters that distinguish *P. gracilis*, sp. nov. from other *Planipapillus* species are given in Figs 2, 5 and Table 1.

Planipapillus gracilis, sp. nov. was found with *Planipapillus biacinoides*. Females of these two species may be difficult to distinguish using morphological characters (see the Remarks section of *P. biacinoides* above) but the differences between the heads of males are very obvious (compare Fig. 10c with Fig. 13c).

Habitat

Planipapillus gracilis, sp. nov. was found in and under dry pieces of timber beside Livingstone Ck. Though largely cleared, this habitat was once open dry sclerophyll forest. Live, hand collected specimens were usually coiled in spiral when first exposed.

Distribution

This species is known only from the type locality (Fig. 7).

Etymology

The Latin specific name ‘gracilis’, means slender, or thin.

***Planipapillus impacris*, sp. nov.**

(Figures 2f; 4f; 5h; 7; 13d; 13e; 15; 16. Table 1)

Material examined

Holotype: ♂, New South Wales: South East Forests NP, Coolangubra Section, 5 km N of intersection of Coolangubra Forest Way and Northern Access Rd, 37°01’S 149°23’E, 800 m, 2 Mar 1999, coll. A. Reid (MV K7291).

Paratypes: 1♂, 4♀, 1 juvenile, data as for holotype (MV K7292).

Additional material. 1♂, South East Forests NP, Coolangubra Section, Waratah Forest Rd., 2 Feb 1989, coll. R. Cameron (MV).

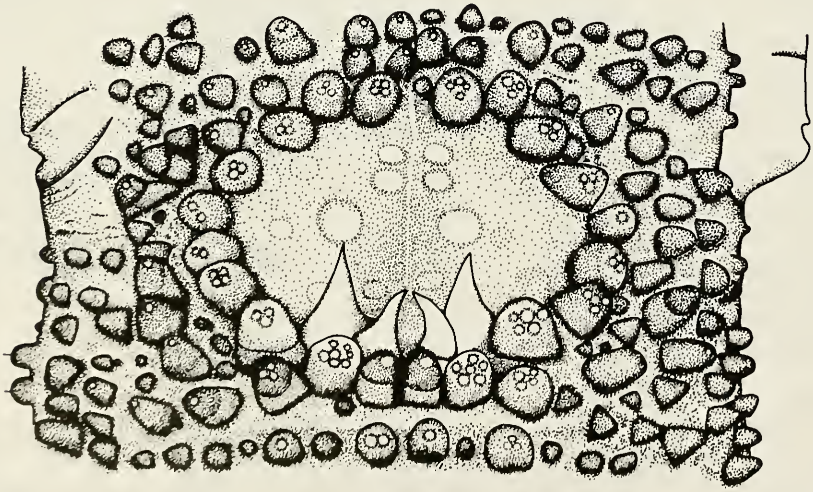

Figure 15. *Planipapillus impacris*, sp. nov., modified region of head, holotype male, 1.12 mm HWE, scale bar 0.25 mm.

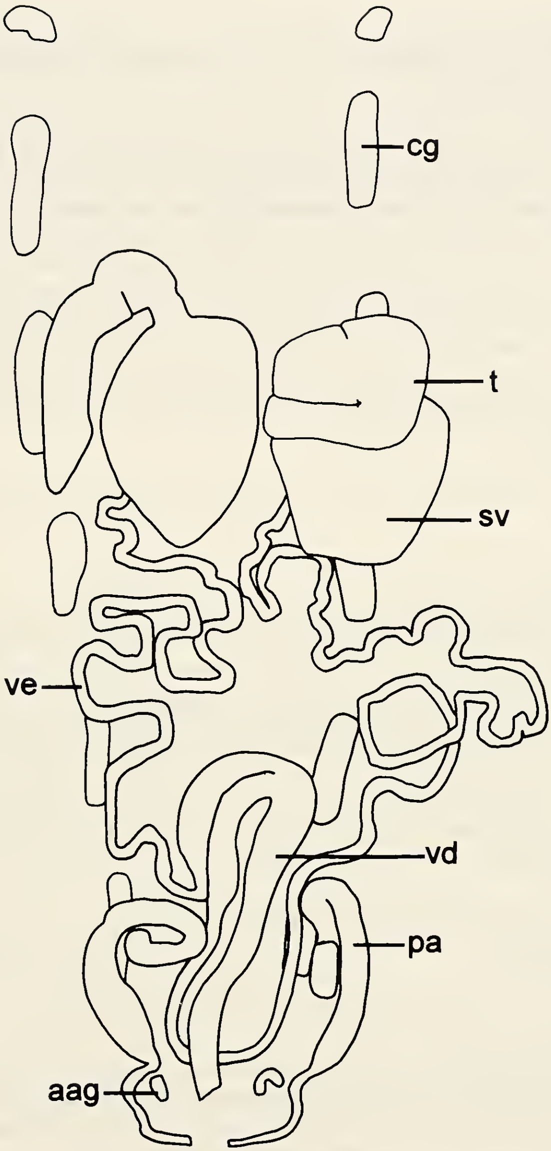

Figure 16. *Planipapillus impacris*, sp. nov., male reproductive tract and associated glands, holotype, 1.12 mm HWE, scale bar 0.50 mm. aag, anterior accessory gland; cg, crural gland; pa, posterior accessory gland; sv, seminal vesicle; t, testis; vd, vas deferens; ve, vas efferens.

Diagnosis

Ovoid patch of reduced papillae in males with four subequal spikes on posterior margin; patch surrounded by single complete row and second partial row (with one dorsolateral and one ventrolateral pair of enlarged papillae) of semicircular papillae; each enlarged papilla with up to seven sensory bristles. Crural papillae on oncopods 6–14 in both sexes. Anterior accessory glands present, greatly reduced.

Description

Measurements

HWE males 0.82–0.98–1.12 mm (n=3, Holotype 1.12 mm); HWE females 1.05–1.12–1.20 mm (n=4).

Colour pattern

Ground colour greyish-blue. Mid-dorsal dark stripe present (Fig. 13d); longitudinal light-coloured band along dorsal midline (juvenile only) and short, dark, transverse bars or blotches along midline, dorsal to oncopods; tan dorsolateral ovoid patches in line with oncopods (juvenile only), or irregular mottling; tan papillae sometimes concentrated mediodorsally (Fig. 13d); laterally with cream or tan patches between oncopods. Oncopods without light patches at junction with feet. Papillae around anal opening pigmented as for rest of body. Ventral pigment present, very pale. Spinous pads greyish-blue. Integument between genital and anal openings pigmented as for rest of ventrum.

Antennal rings banded, tan or with tan mottle dorsally, or not banded, ground colour; dorsal banding on proximal half of each antennal ring (distal half ground colour), with every fourth ring predominantly tan.

Antennal rings

Distal 7–9 antennal rings with sensory bulbs; sensory pads with 2–3 rows of sensilla.

Eyes

EDI males 0.06–0.06–0.07; EDI females 0.06–0.06–0.07.

Head (males)

Males with modified papillae on head (i.e. differ from remaining dorsal papillae). Papillae reduced in transverse ovoid patch posterior to eyes (Figs 2f and 13e). Patch with four sclerotised spikes at medio-posterior margin; median pair smaller than lateral pair; median pair slightly posterior to lateral pair, curved (Fig. 15). Ovoid patch comprising 6–7 rows of plicae; papillae forming patch greatly reduced, or absent; papillar scales fused, papillae smooth, median bristles absent. Papillae adjacent to patch semicircular, enlarged; single row of enlarged papillae, except for one enlarged dorsolateral and one enlarged ventrolateral pair in outer row. Papillae posterior to median two spikes smaller than rest; each enlarged papilla with up to 7 bristles.

Head (females)

Females with no modification of head papillae.

Dorsal integument

Males with 11–15–17, females with 16–17–18 papillae counted from mid-dorsal line to junction of oncopod 10. Primary papillae semicircular.

Male reproductive tract

Male genital pad cylindrical, protuberant. Proximal vasa efferentia lying close together, parallel for part of their length before fusing to form vas deferens, or separate, do not lie parallel for part of their length (Figs 4f and 16); vas deferens continues directly (without looping) from paired vasa efferentia to gonopore.

Male glands and gland papillae

Crural papillae on ventral side of oncopods 6–14. Papillae similar in shape on all oncopods: semicircular or cylindrical proximally, tapered abruptly to narrower, semicircular or cylindrical distal section (papillae on oncopods 10–14 broader than rest). Crural glands extend into lateral haemocoel from oncopods 9–14; straight, short, not folded; remaining glands confined within oncopods. Anterior accessory gland papillae present; large, subconical. Anterior accessory glands present; greatly reduced (Fig. 16). Posterior accessory glands with long hook tapered only slightly to blunt tip (Figs 5h and 16).

Female crural papillae

Present on oncopods 6–14. Not visible on all specimens.

Remarks

The head spikes are well-developed in a small male, 0.82 mm HWE. *Planipapillus impacris*, sp. nov. differs from *P. cyclus* (also with four subequal spikes in the posterior margin of the head patch in males) in the absence of crural papillae on oncopods 2–3 in both sexes. *Planipapillus cyclus* has crural papillae on oncopods 2–3. The head spikes also differ between the two species. The median pair are much larger, and distinctly curved in *P. impacris*, sp. nov. The patch of modified papillae is ovoid in *P. impacris*, sp. nov., and circular in *P. cyclus* (compare Figs 10f and 13e). Differences between *P. impacris*, sp. nov. and other *Planipapillus* are given in Figs 2, 5 and Table 1.

This species was described as ‘taxon I’ by Tait and Briscoe (1990).

Planipapillus impacris, sp. nov. was found with specimens of *Ooperipatus* sp.

Habitat

In decomposing logs. Live, hand collected specimens were usually coiled in spiral when first exposed.

Distribution

Known only from the type locality (Fig. 7).

Etymology

The specific name is derived from the Latin ‘impar’, meaning unequal, or odd, and ‘acris’, meaning pointed. The name refers to the unequal length of the two pairs of head spikes in this species.

Planipapillus tectus, sp. nov.

(Figures 2g; 4g; 5i; 5j; 5k; 7; 17a; 17b. Table 1)

Material examined

Holotype: ♂, Victoria, 6.7 km S of intersection of Gelantipy Rd and Tulloch Ard Rd (10.7 km S of Gelantipy, 300 m N of Forest Ck Tk), 37°17’S 148°15’E, 710 m, 14 Mar 1999, coll. A. Reid and R. Roberts (MV K7293).

Paratypes: Victoria, 3♂ 2♀, data as for holotype, (MV K7294).

Additional material: Victoria, 2♀, Gelantipy, Honeysuckle Tk, Apr 30–May 9 1947, coll. C.W.B and Miss M.B. (MV).

Diagnosis

Males with ovoid patch of slightly reduced papillae on head; anteriorly papillae within patch semicircular with scales; posteriorly papillae ridge-like, smooth, with fused scales; papillae surrounding patch not markedly enlarged. Crural papillae on oncopods 2–3 and 6–14 in both sexes. Anterior accessory glands greatly reduced. Posterior accessory glands straight, blunt (usually), or folded with long hook.

Description

Measurements

HWE males 0.80–0.82–0.85 mm (n=4, Holotype 0.85 mm HWE); HWE females 0.80–0.85–0.90 mm (n=2).

Colour pattern

Ground colour greyish-blue. Mid-dorsal dark stripe absent (Fig. 17a); longitudinal light ground-coloured band along dorsal midline (Fig. 17a); short, dark, transverse bars or blotches along midline dorsal to oncopods and light ground colour dorsolateral transverse patches in line with oncopods, patches flat anteriorly, convex posteriorly, often with prominent whitish papilla on lateral margin of each patch (Fig. 17a), or irregular mottling (one small specimen 0.8 mm HWE); laterally with longitudinal light band dorsal to oncopods, or with light patches between oncopods. Oncopods with cream patches at junction with feet. Papillae around anal opening pigmented as for rest of body. Ventral pigment present; ground colour, lighter than dorsum. Spinous pads greyish-blue. Integument between genital and anal openings pigmented as for rest of ventrum.

Antennal rings banded, tan or with tan mottle dorsally; dorsal banding on alternate rings distal to, and including ring five (every 5th ring with more tan mottle).

Antennal rings

Distal 8–9 antennal rings with sensory bulbs; sensory pads with two rows of sensilla.

Eyes

EDI males 0.06–0.07–0.08; EDI females 0.07.

Head (males)

Males with modified papillae on head (i.e. differ from remaining dorsal papillae). Papillae reduced in longitudinal ovoid patch posterior to eyes (Figs 2g and 17b). Patch without sclerotised spikes at medio-posterior margin. Ovoid patch comprising 15–17 rows of plicae; papillae forming patch only very slightly reduced, semicircular anteriorly, posteriorly papillae are triangular, ridge-like (Fig. 17b); anterior semicircular papillae with scales as for remaining head papillae, not fused; posterior ridge-like papillar scales fused, papillae smooth; each with a sensory bristle. Papillae laterally adjacent to patch semicircular, very slightly enlarged; each enlarged papilla with single bristle.

Head (females)

Females with no modification of head papillae.

Dorsal integument

Males and females with 12 papillae counted from mid-dorsal line to junction of oncopod 10. Primary papillae cylindrical.

Male reproductive tract

Male genital pad semicircular. Proximal vasa efferentia separate, do not lie parallel before fusing to form vas deferens; vas deferens continues directly (without looping) from paired vasa efferentia to gonopore (Fig. 4g).

Male glands and gland papillae

Crural papillae on ventral side of oncopods 2–3 and 6–14. Papillae shape differs among oncopods: oncopods 2–3 cylindrical, oncopods 6–10 and 11–14 papillae semicircular; papillae tapered slightly distally, not divided into distinct basal and distal regions. Crural glands extend into lateral haemocoel from oncopods 11–14; straight, short, not folded; remaining glands confined within oncopods. Anterior accessory gland papillae present; broad, rounded. Anterior accessory glands present; greatly reduced. Posterior accessory glands variable: usually straight, bulbous, blunt distally (Fig. 5i); folded distally with short blunt hook (Fig. 5j); or sometimes constricted forming distal knob (Fig. 5k).

Female crural papillae

Females with crural papillae on oncopods 2–3 and 6–14.

Remarks

Unlike other *Planipapillus,* the papillae on the head patches of male *P. tectus*, sp. nov. are only slightly reduced. Some papillae have ribbed scales and sensory bristles, while others are reduced and ridge-like with fused scales within the head patch. In other *Planipapillus* the papillae are fairly uniformly modified within the head patch. The papillae lateral to the patch in *P. tectus*, sp. nov. are only slightly elongate, thus differing from most other *Planipapillus,* with the exception of *P. vittatus*, sp. nov. Additional characters that distinguish *P. tectus*, sp. nov. from other nominal *Planipapillus* are shown in Figs 2, 5 and Table 1.

The Additional material, two female specimens, are only tentatively assigned to this species. One of these specimens is a large female (1.25 mm HWE) and differs from

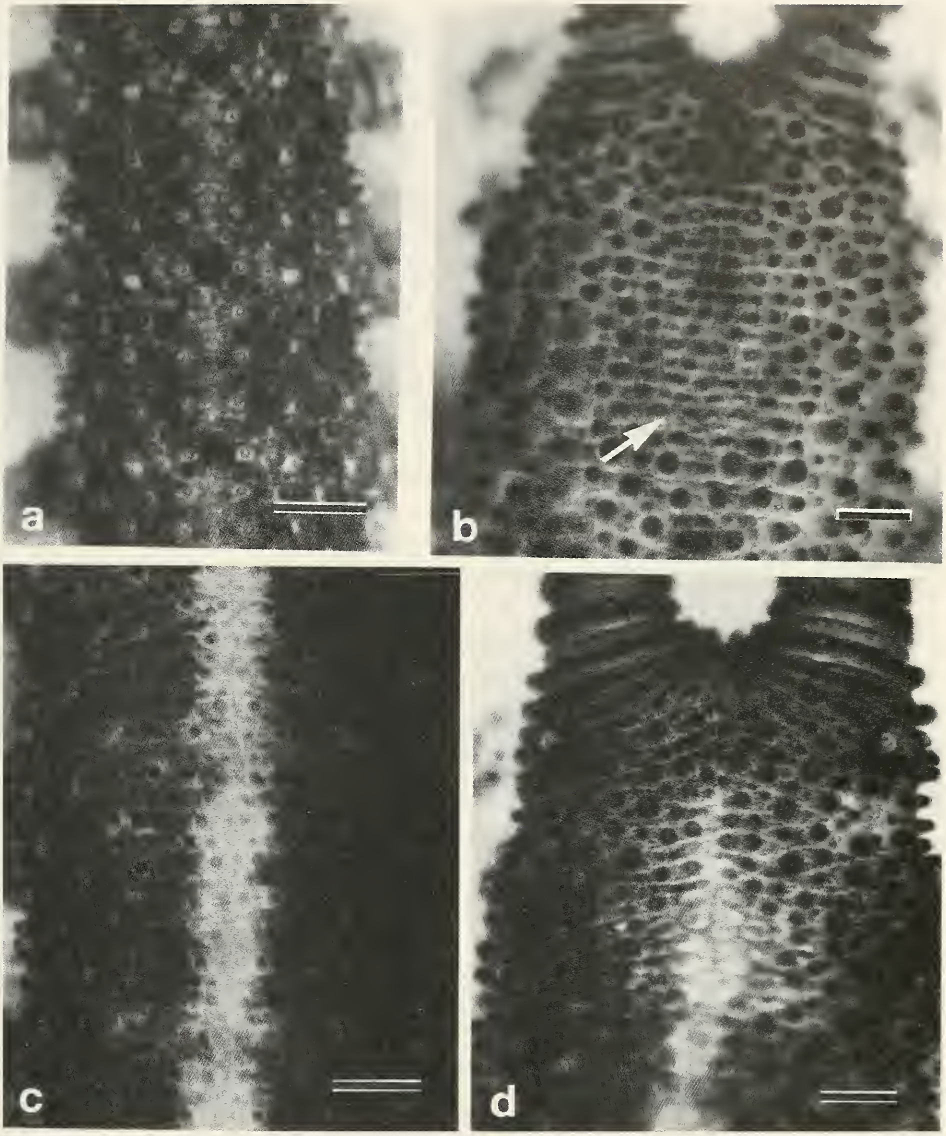

Figure 17. *Planipapillus tectus,* sp. nov.: (a) body, paratype female, 0.90 mm HWE scale bar 0.20 mm; (b) head, holotype male, 0.85 mm HWE, scale bar 0.20 mm. *Planipapillus vittatus*, sp. nov. (the position of the patch of modified papillae is indicated by an arrow): (c) body, paratype female, 1.0 mm HWE, scale bar 0.50 mm; (d) head, paratype male, 0.90 mm HWE, scale bar 0.20 mm.

the type material in being of tan colouration, rather than greyish-blue, although the pattern is the same as the other material examined. This specimen, collected in May 1947, contains thick-shelled eggs in the oviducts.

Habitat

Under logs in dry sclerophyll forest. Live, hand collected specimens were usually coiled in spiral when first exposed.

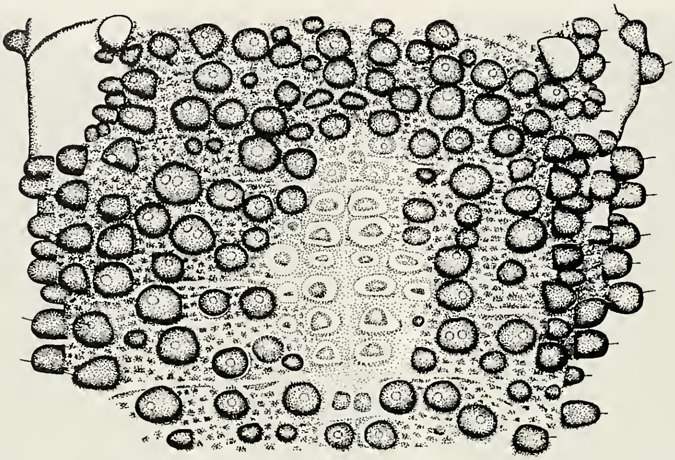

Figure 18. *Planipapillus vittatus*, sp. nov., modified region of head, holotype male, 0.85 mm HWE, scale bar 0.20 mm.

Distribution

This species is known only from the type locality (Fig. 7).

Etymology

The species name is Latin, meaning 'cover'. It refers to the behaviour of this species, found under the cover of logs.

Planipapillus vittatus, sp. nov.

(Figures 4h; 4i; 5l; 7; 2h; 17c–d; 18. Table 1)

Material examined

Holotype: ♂, Victoria, Dinner Plain, 36°59'S 147°17'E, 1628 m, 12 Mar 1999, coll. A. Reid and R. Roberts (MV K7295).

Paratypes: Victoria, 2♂ 7♀, data as for holotype (MV K7296); 2♀, Dinner Plain, 36°59'S 147°17'E, 11 Jan 1990, coll. N.N. Tait (MV K7297).

Diagnosis

Patterned with distinctive median longitudinal tan stripe on dark grey body. Males with small patch of reduced ridge-like papillae on head; 5–6 rows plicae comprise patch; median pair largest; papillae surrounding patch not enlarged. Males with crural papillae on oncopods 2–3 and 6–14; females with crural papillae on oncopods 6–14.

Description

Measurements

HWE males 0.77–0.84–0.90 mm (n=3, Holotype 0.85 mm HWE); HWE females 0.57–0.86–1.00 mm (n=9).

Colour pattern

Ground colour dark greyish-blue (sometimes with tan mottle). Mid-dorsal dark stripe absent; distinctive longitudinal tan band along dorsal midline, extending from midpoint of eyes to last oncopod pair (Figs 17c and 17d), band sometimes interrupted by greyish-blue or brown patches dorsal to oncopods; evenly scattered tan or tan-based papillae (some specimens only); cream dorsolateral transverse patches in line with oncopods [juvenile (0.57 mm HWE) only]; laterally with longitudinal cream band dorsal to oncopods, or with light patches between oncopods. Oncopods without light patches at junction with feet. Papillae around anal opening pigmented as for rest of body. Ventral pigment present, very pale. Spinous pads greyish-blue. Integument between genital and anal openings pigmented as for rest of ventrum.

Antennal rings not banded, ground colour.

Antennal rings

Distal 8–9 antennal rings with sensory bulbs; sensory pads with two rows of sensilla.

Eyes

EDI males 0.05–0.05–0.06 (n=3); EDI females 0.04–0.05–0.07 (n=9).

Head (males)

Males with modified papillae on head (i.e. differ from remaining dorsal papillae). Papillae reduced in an ovoid-squarish patch posterior to eyes (Fig. 2h). Patch without sclerotised spikes at medio-posterior margin (Figs 17d and 18). Ovoid patch comprising 5–6 rows of plicae; papillae forming patch triangular, ridge-like; papillar scales fused, papillae smooth; 2–4 modified papillae on each plica, median pair largest (Figs 17d and 18), median bristles absent. Papillae adjacent to patch not enlarged; each papilla with up to two bristles.

Head (females)

Females with no modification of head papillae.

Dorsal integument

Plicae uniform width. Males with 10–10–11, females with 6–12–17 papillae counted from mid-dorsal line to junction of oncopod 10. Primary papillae semicircular.

Male reproductive tract

Proximal vasa efferentia lying close together, parallel for part of their length fusing to form vas deferens; vas deferens continues directly (without looping) from paired vasa efferentia to gonopore (Figs 4h and 4i).

Male glands and gland papillae

Crural papillae on ventral side of oncopods 2–3 and 6–14. Papillae similar in shape on all oncopods: semicircular or cylindrical proximally, tapered abruptly to narrower, semicircular or cylindrical distal section (oncopods 2–3) or semicircular or cylindrical, tapered slightly distally, not divided into distinct basal and distal regions (oncopods 6–14). Crural glands extend into lateral haemocoel from oncopods 11–14; sometimes folded back along length; remaining glands confined within oncopods. Anterior accessory gland papillae present; semicircular. Anterior accessory glands present; greatly reduced. Posterior accessory glands folded distally, long hook tapered only slightly to blunt tip (Fig. 5l).

Female crural papillae

Present on oncopods 6–14.

Remarks

The bold longitudinal tan stripe on the body distinguishes both sexes of *P. vittatus,* sp. nov. from all other *Planipapillus.* The small patch of ridge-like papillae on the heads of males, the median pair of which is enlarged, is also very distinctive in this species. Other distinguishing characters are shown in Figs 2, 5 and Table 1.

One female specimen (collected on 11 Jan 1990) has a patch of reduced papillae on the head. This patch of reduced papillae is much larger than the modified patch seen in the males of this species. The region may be the result of a wound to the head, though it is strange that this patch of reduced papillae is in the same position to that seen in males. No other females showed any modification of the head papillae. Females collected on 12 Mar 1999 contained eggs at various stages of development along the length of the oviducts, though none were well-developed. The females collected on 11 Jan 1990 contained large, thick shelled eggs in the oviducts.

Habitat

Under dry logs at the edge of grassy paddock. The predominant vegetation in the region is snow gum woodland. Live, hand collected specimens were usually lying flat and straight when first exposed.

Distribution

Known only from the type locality (Fig. 7).

Etymology

The species name, 'vittatus' is derived from the Latin, 'vitta', meaning band, or stripe, and refers to the distinctive dorsal pigmentation in this species.

ACKNOWLEDGEMENTS

I wish to thank Bert Roberts and Anne Skates for their company and assistance with fieldwork. Thanks to Sue Boyd, Chris Rowley and Ken Walker for the use of microscopes and photographic equipment in their departments at Museum Victoria.

Many thanks also to Noel Tait for his thorough review of this manuscript and constructive suggestions which resulted in its considerable improvement. In addition, he first discovered three of the sites from which I collected specimens described in this paper.

The Australian Biological Resources Study funded this work. I am very grateful for this support.

REFERENCES

Briscoe, D.A. and Tait, N.N. (1993). Peripatus or velvet worms. In 'Tasmanian Wilderness – World Heritage Values' (Eds S.J. Smith and M.R. Banks) pp.136–138. (Royal Society of Tasmania: Hobart).

Dallwitz, M.J. (1980). A general system for coding taxonomic descriptions. *Taxon* **29**, 41–46.

Dallwitz, M.J., Paine, T.A. and Zurcher, E.J. (1993). 'Users Guide to the DELTA System: a General System for Processing Taxonomic Descriptions'. 4th Edn. (CSIRO Division of Entomology: Canberra.).

Dendy, A. (1900). Preliminary note on a proposed new genus of Onychophora. *Zoologischer Anzeiger* **23**, 415–416.

Gleeson. D.M. (1996). Onychophora of New Zealand; past present and future. *New Zealand Entomologist* **19**, 51–55.

Meredith, P. (1995). Headfirst. Passion goes to the velvet worm's head. *BBC Wildlife* **13**(6), 26.

Partridge, T.R., Dallwitz, M.J. and Watson, L. (1993). 'A Primer for the DELTA System'. 3rd Edn. (CSIRO Division of Entomology: Canberra.).

Reid, A.L. (1996). Review of the Peripatopsidae (Onychophora) in Australia, with comments on peripatopsid relationships. *Invertebrate Taxonomy* **10**(4), 663–936.

Sunnucks, P. and Wilson, A.C.C. (1999). Microsatellite markers for the onychophoran *Euperipatoides rowelli. Molecular Ecology* **8**, 899–200.

Tait, N.N. and Briscoe, D.A. (1990). Sexual head structures in the Onychophora: unique modifications for sperm transfer **24**, 1517–1527.

Tait. N.N. and Briscoe, D.A. (1995). Genetic differentiation within New Zealand Onychophora and their relationships to the Australian fauna. *Zoological Journal of the Linnean Society* **114**, 103–113.

Trewick, S.A. (1998). Sympatric cryptic species in New Zealand Onychophora. *Biological Journal of the Linnean Society* **63**, 307–329.